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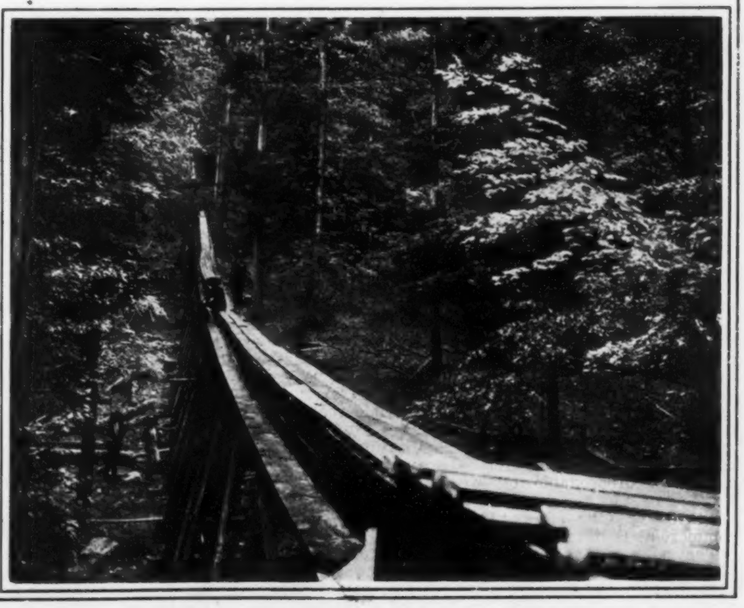
WASHING MONAZITE SAND FROM CREEK BASIN.

PLACER MINING IN STANLEY COUNTY.

SLUICES AT PARKER MINE.

SLUICING PARKER MINE, STANLEY COUNTY.

WASHING GRAVEL FROM MONAZITE SAND AT PHEIFER MINE, CLEVELAND CO.



TRESTLE SUPPORTING WATER PIPES OF PARKER MINE.

GOLD MINING IN SOUTHERN UNITED STATES.

GOLD IN NORTH CAROLINA.

By Frederic Moore.

North Carolina is the pioneer gold State of this country.

Besides seeking the salvation of souls, the early European visitors to the South Atlantic States were impelled by the desire to acquire gold. There is nothing remarkable, therefore, in the fact that the early narratives report the presence of gold all along the section. As early as 1513 Ponce de Leon reported that a cacique in Florida had an abundance of it; but this, like most of the subsequent reports, was founded more on hope than actual discovery. Lack of success killed the hope in the early gold-seekers, and the search for the precious metal was given up until 1799, when a man named John Reed found in Carribus County a nugget weighing 17 pounds. And not even from that year does the beginning of gold mining in this country date, for it was four years after the find—during which time Reed used the nugget as a door prop—that it was ascertained to be gold.

When this discovery was made, further search was immediately instituted, with the result that many more nuggets were found, the largest of which weighed 28 pounds. In a year gold hunting had fairly begun, and from that time until 1827 all the gold produced in this country came from North Carolina. But the total amount during that time, so far as records go, was of only $110,000 value.

Up to 1825 all the gold came from washings. In that year a successful excavation was made in Montgomery County; then valuable quartz veins were located in Mecklenburg County, and from that time the mining of gold proceeded.

It was because the streams of the State became exhausted, in so far as the methods of extraction then in use were concerned, that attention was turned to vein mining. When, in 1834, the streams were practically abandoned, newly-located veins gave fresh impetus to the business. The South reached the highest point it had yet attained as a result. In the forties $1,000,000 of gold was produced, far the largest portion coming from North Carolina, though South Carolina, Virginia and Georgia were by this time producing gold. In the fifties a decrease set in in the production of the metal, with a practical cessation during the civil war. Immediately thereafter, however, the interest in gold mining revived; but the maximum output, about a quarter of a million dollars, has never been a factor in the production of the country (now between $70,000,000 and $80,000,000) since the western territory was opened.

The virgin ground where placer mining was operated in North Carolina undoubtedly yielded handsome returns; for many of the old tailings, imperfectly worked, have been washed over a second and a third time—even to a seventh—with a profit.

Through this placer mining, the first mode of getting gold in North Carolina, many of the mechanisms now universally used—for instance, the rocker and the "Long Tom"—originated. In the past, placer deposits have been worked with considerable energy and system. In the South Mountain Mining district there has been much work done in a small way, chiefly by men and women working singly or in small gangs, the pan being the most common means of separation.

Occasionally these people strike a pocket with from $5 to $100 in it, but for the rest they subsist on trifling quantities of gold and great expectations. It is said that an average of 60 or 70 cents per day can be made by a skillful and industrious workman. The women, beginning in childhood, develop great acumen in selecting the best gold-bearing land and become very expert in panning it.

At present very few placer mines are in operation. The Crawford mine, in Stanley County, four miles south of Albemarle, was opened on a fresh bed in 1892. The gravel consists of angular quartz and slate fragments in a clay matrix, and occurs in a narrow stream bottom about 250 feet wide. Its thickness is from one and a half to two feet and the overlay is from two to four feet deep. Owing to the scarcity of water, a method of washing, out of the ordinary, was pursued. A wooden tank of 200 cubic yards capacity was placed at an elevation above the stream bed. At one end was set up a standpipe, 30 feet high, which was supplied by a steam pump from a reservoir below. The gravel was hauled to the top of the tank in tramcars and dumped. Here it was washed by a discharge from the standpipe. A line of riffled sluice boxes ran from an opening in one side and near the bottom of the tank. The gold was collected from the tank bottom and the riffles in the sluices.

The gold occurs almost exclusively in the shape of nuggets. In April, 1895, an 8-pound nugget was found, and in August one weighing 10 pounds. The cost of working averaged about 50 cents per loose cubic yard.

The Mills property at Brindleton, Burke County, was worked over ground that had already been covered by the early hunters. Other placers of some importance are the Sam Christian mine, Montgomery County, and the Parker mine, Stanley County. In the South Mountain region the mining of large veins has been attempted to some extent, and several shafts have been sunk to a depth of 100 feet. The ore from these shafts looks good and is said to assay extremely well, $15 or $20 being asserted as the average, and much higher values being sometimes given. Though mining is sporadic throughout the State, fine specimens are frequently found, and very often the assay office in Charlotte shows ores running above $60 per ton. The ores can be mined and reduced for $3 per ton or thereabout, and it seems incredible that veins 18 inches or more in width, averaging $10 a ton in assay, should be allowed to remain idle. For economic reasons veins should be prospected with local capital. If reasonable quantities of gold with an average of $10 can be put "in sight," i. e., exposed on three or four sides, plenty of capital from the commercial centers will be forthcoming.

The veins are, as a rule, of comparatively moderate dimensions as compared with the great quartz lodes of California, but they are often more abundant within a given area, and within the zone of oxidation portions have proven exceptionally rich in free gold.

The configuration and physical character of the country is not such as to favor the accumulation of large bodies of placer gravel, yet, occurring as it does in the unglaciated region, the surface material in the vicinity of the outcrops of veins, as a result of the secular disintegration, is often rich enough to be worked profitably as placer deposits. When the limit of the zone of oxidation has been reached, the sulphuret ores are generally found to be of too low grade to be profitably amalgamated, and this treatment is sometimes further complicated by their association with tellurium. Hence the many abandonments of mining when the workings were still comparatively shallow, and the impression has gotten abroad that gold is not found at greater depths.

There is less positively known with regard to the geology of the rocks in which gold veins occur, and the relations of the deposits themselves, than there is of any other gold-bearing deposits in the country. It is probable that to this ignorance, combined with a want of technical knowledge on the part of so many of those who have attempted to mine gold, may in a great measure be attributed the many financial disasters that have brought gold mining in the State into ill repute.

When the geology of the belt becomes better known, and the mining falls entirely into the hands of those who have not only sufficient capital but also the necessary practical knowledge, the gold yield of the State will be considerably larger and gold mining will undoubtedly prove to be profitable.

THE COAL FIELDS OF THE UNITED STATES.

The third part of the Twenty-second Annual Report, 1900-1901, of the United States Geological Survey, dealing with Coal, Oil, and Cement, is now passing through the press. The volume is the answer to many requests made to the Geological Survey for information concerning the coal supply of the country, and is based on geographic, geologic and trade relations. The introductory part, by Dr. Charles Willard Hayes, Geologist, discusses briefly the distribution, development, production, and markets of the coal fields of the United States.

The total coal areas foot up some 280,397 square miles, exclusive of Alaska, and exclusive also of vast areas of lignite coal not strictly comparable with the higher grade anthracite and bituminous coals. Of this total area approximately 55 per cent is probably productive. The rank of States in production differs greatly from their rank in coal area. Thus Pennsylvania, ranking seventh in coal area, was easily first in production in 1900, with a little over 132,000,000 short tons out of a total production of about 241,000,000 tons. The same is true of the Northern Appalachian field as a whole, which, third in area, ranks first in tonnage and value of product, a result due to proximity to market, suitability of coal to fuel requirements, and relative quantity of workable coal per square mile of productive area. The anthracite field consists of several long, narrow basins in eastern Pennsylvania. Several small basins of Triassic rocks in the Piedmont region of Virginia and North Carolina, containing an aggregate of about 1,000 square miles, are coal bearing.

The Appalachian field, subdivided into northern and southern, extends from northern Pennsylvania 850 miles to central Alabama, embracing portions of nine States, and containing approximately 70,800 square miles, of which about 75 per cent contains workable coal. The Northern Interior field lies wholly within the State of Michigan with an area of approximately 11,000 square miles. The Eastern Interior field, lying in Indiana, Illinois, and Kentucky, has an area of 58,000 square miles. It is estimated that about 55 per cent of this area is productive. The Western Interior and Southwestern fields form a practically continuous belt of Coal Measure rocks, extending from northern Iowa southwestward 880 miles to central Texas and embracing an area of 94,000 square miles. The Rocky Mountain fields extend from the Canadian borders southeastward some 1,200 miles, with a maximum breadth of 500 miles and aggregate 43,610 square miles. The San Carlos field, El Paso County, Texas, and the Eagle Pass field, extending from Uvalde County, Texas, 75 miles to the Rio Grande and across into Mexico, properly belong to the Rocky Mountain field. The Pacific coast coal fields have a total area of about 1,000 square miles, with the most important deposits in Washington, a few deposits in extreme western Oregon and in central and southern California.

The lignite coal deposits, which are not treated of in this series of papers, embrace about 56,000 square miles in Montana, the Dakotas, and Wyoming; and then, in an area of about equal extent, they run in a narrow belt from the Georgia-Alabama line nearly to the Mississippi, and then west of the Mississippi in a broader belt, from Little Rock southwestward through Arkansas, Louisiana, and Texas.

The Appalachian field presents certain well-marked types of coal which for particular purposes are regarded as standard. The coal of the Connellsville district of the Pittsburg bed is the standard for coking coal, as the Pocahontas coal of West Virginia is the standard for steam coal. The Northern Interior field, of Michigan, contains only bituminous coal, a fair steaming fuel. In the Eastern Interior field, the largest part is a soft bituminous fairly good steam coal; then there is the block coal in Indiana; and also numerous small areas of cannel coal, valuable for gas making and for domestic purposes, in Kentucky. The coal of the Western Interior fields is fairly uniform in composition and makes a fair steaming fuel. In the Southwestern Interior field the coal varies from a soft bituminous in northern Texas to semi-anthracite in Arkansas. In the Rocky Mountain and Pacific fields the coal varies from lignite to anthracite. Owing to location and character of coal, the northern Appalachian field controls the coal trade of the Eastern States, sending its coal to the seaboard by the trunk-line railroads. It competes with the interior coal fields to the west by way of the Great Lakes and the trunk-line railroads, and to the south by way of the Ohio River. The Southern Appalachian field supplies the South Atlantic and Gulf States as far west as the Mississippi, and Dr. Hayes thinks this field will in time support a large export trade to Central and South American ports, and, after the Isthmian canal is built, to Pacific Coast ports also. The markets for the coal of the Northern and Eastern Interior fields are chiefly within their own limits, and they are in more or less competition with the Appalachian coal, and with the natural gas of Ohio, Indiana, and Kentucky. The Western Interior coal field supplies its own markets and those toward the north and west, where it must compete with the Rocky Mountain fields. The Southwestern Interior field has but little competition except from fuel oil in a large territory toward the south and west. Practically all the coal fuel used by the southern transcontinental railroads, as well as the Texas roads, comes from the north Texas and Indian Territory fields. Considering the entire region between the Appalachian coal field and the Rocky Mountain fields, there is observed a general movement of the coal westward, a tendency due chiefly to the higher grade of the eastern coals, but also in part to the generally lower westward railroad freights and to the ease of westward water transportation. The region west of the one hundredth meridian—about half the area of the United States, Alaska excepted—contains less than 20 per cent of the coal fields. The development of the coal resources of Alaska is as yet in the experimental stage. Practically all the information at present available concerning these Alaskan coal fields is summarized by Mr. Brooks in his paper, which should form an invaluable aid in future prospecting and development.

WELLS OF SOUTHERN CALIFORNIA.

In the Series of Water Supply and Irrigation Papers, the United States Geological Survey has in press, but not yet published, the "Wells of Southern California" (Nos. 59 and 60), by Mr. Joseph Barlow Lippincott. In his letter of transmittal Mr. F. H. Newell, Hydrographer in Charge, remarks: "The results are instructive, as showing what may be done in other parts of the United States under favorable conditions of climate and soil, and have peculiar interest in any consideration of the extent to which the arid land can ultimately be redeemed by irrigation."

The region discussed is the San Bernardino Valley in Southern California, which has an area of 563 square miles, and lies south and west of the Sierra Madre and San Bernardino Mountains. Riverside and Redlands are the centers of fruit production. Up to elevations of 2,000 feet the relatively high lands are free from frost, and the relatively low lands are subject to it. The distinctive crop of San Barnardino Valley is citrus fruits. Oranges predominate, followed next by lemons, and of late years the grape fruit has become a popular product. Olives, almonds, prunes, apricots, peaches, pears, and wine, raisin, and table grapes, are all grown to perfection in this district. In the eleven years prior to 1898 Riverside shipped nearly seven million boxes of oranges, an average annual income of $1,000,000.

Water is the lifeblood of the land. Without it this valley would become a semi-desert. The rain clouds from the Pacific Ocean are condensed against the 6,000 to 11,000-foot elevations of the Sierra Madre and San Bernardino Mountains, in the winter time usually in the form of snow, which feeds the streams up to about May. Mr. Lippincott classifies the water supply as surface streams, underground water, and storage reservoir water. The Santa Ana and other mountain streams have brought down detritus and built up deltas in the valley. The winter floods gradually disappear in flowing over these deltas and, sinking down, form reservoirs of artesian water of unknown but great capacity. In addition to the winter floods the summer flow of all the streams from San Antonio Creek to Mill Creek is diverted and used for irrigation purposes, and probably 50 per cent of it sinks into the ground and reinforces the water plane. This large underground reservoir slopes toward Santa Ana River, the most important stream of Southern California west of the Coast Range. It drains a total area above Rincon of 1,657 square miles; 971 square miles of the basin are mountainous. The controlling outlet of this great underground reservoir is at Rincon, where there is a larger body of water flowing during the summer than at any other place in California south of the Tehachapi Mountains, except along the Colorado. If an area of gravel of 500 square miles should be charged to a depth of 300 feet—a fair average depth to assume for this valley—its storage capacity would be 32,000,000 acre-feet of water. These figures suggest the enormous capacity of this great underground storage reservoir of San Bernardino Valley. It has been charged with waters through a long cycle of years by the floods described. Hence measurements made in the summer of 1898 showed that there was almost three times more water rising in the central portion of the valley than there was entering the valley from the mountain drainage basin.

Mr. Lippincott holds, therefore, that properly located development works near Rincon, permitting the lowering of this water plane each season 21 feet over an area of 1,000 acres, should yield from 1,500 to 2,000 miners' inches of water. He thinks the proper method of procedure should be to divert, for the creation of pumping power, the entire flow of the Santa Ana River, near the Auburndale bridge, about the first of May, and to return the water to its natural bed at the close of the irrigation season. His conclusions are: That a large percentage of irrigation water returns to the channels of the streams; that the movement of the water through the soil being exceedingly slow, this return water from irrigation will be a permanent source of supply; that water of this character is now making its appearance on the lands near Rincon; that it is impossible to determine the amount of water that could be gathered by collecting galleries on these lands; that the stream measurements show a loss between Rincon and the head of the Santa Ana River of about 800 miners' inches, which might be saved by a lined conduit extending down the canyon about 7.4 miles; that a power canal, water wheels, electric machinery, twenty pumping plants, and the gathering flumes necessary for 2,000 miners' inches of water could be constructed at an approximate cost of $75,000.

Numerous tables, eleven plates, and fourteen figures illustrate the discussion.

Mr. Lippincott's contribution concludes with a brief description of the California Portland Cement Company's works at Colton in this valley, the only Portland cement plant on the Pacific Coast. With abundant crude materials of calcspar, clay and almost chemically pure limestone near at hand, and with the Los Angeles petroleum for cheap and excellent fuel, the company is enabled to produce a first-class cement for about three-fourths the price of foreign cements. This is of great consequence for the development of the irrigation interests of the valley.

STORAGE OF WATER ON KINGS RIVER.

KINGS River drains the western slope of the Sierra Nevada in Fresno County, California, from Mount Whitney on the south to Mount Goddard on the north. Fully 80 per cent of the drainage basin is now included within the boundaries of the Sierra Forest Reserve, a matter of prime importance to the irrigated lands below, for it means the conservation of the stream. The river debouches from its mountain drainage basin upon the plains of Fresno, Kings and Tulare counties, sometimes spoken of as the Kings River delta, which are near the geographic center of the State, and present great variety of climate and soil. Fresno and Hanford, the principal towns, are about 200 miles distant from San Francisco and Los Angeles.

Lumber, gold, copper, petroleum, grain, oranges, lemons, many varieties of deciduous fruits, grapes, raisins, wines, and brandies are produced in this region in commercial quantities. There are more than 500,000 deciduous fruit trees in Fresno County. There are about 40,000 acres of vineyards. It is the great raisin district of California. The citrus belt, as is the case in Southern California, is a narrow strip of land at the base of the mountains.

Irrigation is necessary for all varieties of agricultural products, grains possibly excepted. There are about 625 miles of main irrigation canals, covering 380,000 acres of land on the Kings River delta. A good water right adds about $50 per acre to the value of the valley lands, and about $90 per acre to the so-called frostless foothill lands, where the citrus fruits, the most valuable crop, could be raised with an increase of the present supply of water, which has been diverted chiefly to the lower lands. The present combined capacity of the Kings River canals is stated to be approximately 4,000 cubic feet per second; in September, 1898, the supply fell to about 145 cubic feet per second. During the last season the profits from the irrigated districts around Fresno were in excess of $2,000,000. Land without irrigation supply sells here for $10 per acre; the same land with a good water right sells for about $60. Hence the importance of the water power development considered in this report, which is on the Middle Fork of Kings River, above all diversions for irrigation or for storage. Kings River can be relied on, in spite of occasional seasons, for a great water supply, draining as it does 1,742 square miles of area from banks of perpetual snow.

In the investigation of the Kings River basin a reconnoissance party under Mr. E. G. Hamilton, Topographer from the United States Geological Survey, reported upon reservoir sites, four of which were then surveyed by a party under Mr. E. H. Green. Of these four sites Mr. Lippincott thinks that two should be utilized, and that storage work should be begun by building the Clark Valley reservoir with an 85-foot dam, and should be followed by the construction of a 140-foot dam at the Pine Flat site.

The Pine Flat site, on the main Kings River, five miles below Trimmer, just above the diversions of all irrigation canals, has an elevation of 600 feet, and the dam would cost $1,425,600. This reservoir could be used as a governor for filling the Clark Valley reservoir, and then for holding the surplus water. Mr. Lippincott's conclusions are: That the observed flow of Kings River for the season of 1897-98 may be taken as a minimum; that these minimum years will probably occur about once in ten years; that there will be enough water during November to February, inclusive, to fill every year the Pine Flat reservoir with a capacity of 78,197 acre-feet; that in nine out of ten years there will be enough water to leave the Pine Flat reservoir full for use after July 1; that water that would be stored in the Pine Flat reservoir is water that would otherwise be lost; that the Pine Flat reservoir would irrigate the most valuable lands in Fresno and Tulare counties, now dry and unproductive; that the cost of storage would be $18.23 per acre-foot, and the earning power of the reservoir fully double that amount.

The Clark Valley site is in Fresno County, sixteen miles east of Sanger, and has the stage road to Millwood and the arroyo of Wahtoke Creek through the center of it. The elevation of the base of the dam is 400 feet. It is proposed to fill this reservoir by a diversion canal 53,600 feet in length, with headworks above the mouth of Mill Creek and at the Pine Flat dam site. Two additional dams would be needed to block the valley completely up. The total cost, including supply canal, etc., would be $1,331,025; the total storage capacity would be 120,499 acre-feet of water; and the cost per acre-foot of water would be $11.05. Mr. Lippincott thinks that the Clark Valley dam should eventually be raised to 105 feet with a storage capacity of 217,196 acre-feet, and shows by a table that, with this larger dam, there would have been only one year out of eleven when both reservoirs could not have been filled.

The report then shows that the cheapest water supply in the valley can be obtained by pumping with electric power generated by the river itself before it reaches points of diversion or storage, provided the pumping plants are operated at least half the time. A good location for the power house between the Middle and the South Forks, at an elevation of 1,980 feet, with an available head of 650 feet, was found by Mr. E. H. Green, who estimated the total cost of construction at $271,975, and the mean minimum horse power at 7,386. The supply of water in the valley for pumping, based upon reports from over 800 existing wells, was investigated by Mr. Louis Mesmer, who concluded that 300,000 acre-feet could be obtained with certainty by pumping from the water plane of the Kings River delta. The transmission of power and the operation of the pumping plants was investigated by Mr. Lewis A. Hicks, who concludes that the annual pump output would be 328,500 acre-feet on the basis of use for 328½ days, at a cost of $10.50 per acre-foot produced.

By these means 200,000 additional acres of irrigated land could be added to the community.

Mr. F. H. Newell, Hydrographer in Charge, says in his letter of transmittal: "The situation on Kings River is to a certain extent typical of that along a number of important streams of the West, and as a result of this investigation it is believed that the reclaimable area can be greatly extended by the construction of storage works, and also of power plants by means of which, through electrical transmission, pumps can be operated at small expense out on broad valleys. The demonstration of these conditions will prove one of the most important steps toward the transformation and utilization of the fertile but arid lands."

AGRICULTURE IN SIBERIA.

RICHARD T. GREENER, United States commercial agent at Vladivostock, Siberia, has submitted a report on agriculture and farm machinery in Eastern Siberia, which, in part, is as follows:

"Enoch Emory came to Siberia from Cape Cod forty years ago. He was the pioneer American merchant, and now has stores at Nikolaefsk, Habarofsk, Blagoveschensk, and Moscow. Gov. Grodekoff said that he has increased the working force of the Amur territory 20,000 men by the introduction of American labor-saving machinery. Most of the supplies under the head of emigrant stores are furnished to the local government by him.

"American agricultural machines have enjoyed such an established reputation that it has long been a paying business to imitate them. The complaint now is that many cheap and inferior machines, mostly made in Germany from American models, are on the market. Since the retaliatory tariff took effect, February 7 (20), 1901, many American machines come via Germany, it is asserted, all American marks being carefully obliterated.

"At present there is no great demand for American machinery. The market is well stocked, crops are bad, money is scarce, the government is closing down on credit, and the condition of the Siberian peasant farmer is deplorable. Efforts are being made to teach the peasant how to farm. In the United States the foreign immigrant learns by everyday example rather than by theory. The Siberian peasant is not used to severe and unremitting labor; he has few wants and many holidays. Lately some highly colored reports have reached us from America as to what Siberia was capable of doing in an agricultural way. It is suggested that American flour mills on the Pacific Coast will soon be closed in consequence of the millions of acres here ready to be devoted to cereals. An uncertain climate, imperfect machinery, and unreliable labor are not factors for successful competition with the United States.

"Notwithstanding the cheap transportation offered emigrants and the development of virgin soils, famine seems a periodical visitor, and it is here to-day. The central governments are literally besieged with clamors for bread, for medicine, for work, grain, hay—anything. Tomsk, Perm, Kerson, Yaronej, Khalkinsk, all join in this demand. It is safe to say that the United States need have no immediate fear of competition from this quarter, whether it be in grain or machinery, canned goods or cotton goods, production of gold, or building of ships. The new tariff has caused a rise in the price of all necessaries. It has made imperative an imperial ukase allowing employés of the Ministry of the Interior one month's pay. The appropriation has already been made."

THE NAMES OF STARS.

WHO first gave stars their names? Greek mythology, to be sure, credits their naming to Prometheus. It is most remarkable that among peoples equally cultured, star myths resemble one another strikingly. The earlier myths of classic Europe take us back to a time when people had reached a point of civilization about as high as that of the American Indian. The myths and traditions of individual nations are almost identical, at least in spirit.

The folklorist, far more than the historian, realizes the touch of nature that binds all people together. The earliest Greeks of whom we have any record personified the stars as beasts. If we cross to South America, we find that the old Peruvians also worshiped the stars under the names of beasts. The name of the "Great Bear" is as old as Homer and perhaps older. Curiously enough the North American Indian calls the same constellation a "Bear." From what did the coincidence arise? Surely, not from any likeness in the stars themselves.

That the stars were once human beings is an idea that also prevails among the Eskimos. Can it be asserted that Eskimos and Bushmen and North American Indians have simply imitated primitive Orientals? Greece, to be sure, probably borrowed her myths from Egypt, but it is hardly credible that Australia should borrow its star knowledge from Greece. We must rather conclude that the personification of the heavenly bodies is an inherent tendency of the early stages of culture, and that by similar processes of observation and reasoning they have arrived at similar results.

To quote from a writer on this subject, "From savagery up to civilization there may be traced in the mythology of the stars a course of thought, changed indeed in application, yet never broken in its evident connection from first to last. The savage sees individual stars as animate beings, or combines star-groups into living celestial creatures, or limbs of them, or objects connected with them." Nature presents one school for man's education; she trains Assyrian, Hellene, and Polynesian in the same manner. Every nation passes through its stone age to its age of metal, and the order of folk-tales is as regular as geologic strata. Assuming also that man started from one geographic center, it may be conceded that he carried some root-ideas with him as he spread across the world. One of these root-ideas was apparently a glimmering of mythologic astronomy.

It is conceivable that the naming of stars took place before anything like practical astronomy was cultivated. It is usually thought that the Chaldeans were the first to originate the science, and to them is attributed the division of the sun's course into twelve equal parts, marked by his passage through the signs of the zodiac. But perhaps the arrangement of the zodiacal signs should be credited to the Egyptians. . . . A tale told by the natives of Australia is that the Pleiades were a queen and her six attendant damsels, but an ardent lover ran away with the queen and her maidens have ever since mourned her absence. There is certainly no lack of imagination in the myths of these Australasian natives, whose civilization was too backward to enable them to survive the contact with white culture. They conceived the sun as a woman of loose character, flaunting her red mantle, given her by an admirer, in the face of the moon, a man. There is a wilder touch of poetry in many of the aboriginal myths than in those of classic times; but we must remember that the classic myths have undergone centuries of polishing at the hands of cultured poets and romancers. The fancy of comparative moderns has never been lacking in interpreting the names of stars and constellations. One writer has supposed that the Dolphin was the fish that swallowed Jonah; and the Dragon has been imagined to be the serpent of Paradise. The sign of Lyra has been explained as the lyre of Orpheus, the harp of David, and the manger of Bethlehem; while Leo has, of course, been claimed as the Lion of the tribe of Judah. Perseus, says one interpreter, is David bearing the head of Goliath. We must be very careful not to attach weight to any such explanations. The names of stars are for the most part of immemorial antiquity. In many cases they are developments of man's early ideas of totemism and of god-ancestry. They are generally older than the tales that are now quoted with them; and, even where there is a coincidence in name and legend, we must believe rather that they sprang from a common tendency in man, than that they come from one common stock of tradition.

RARE FINDS IN ARMENIA.

THE interest of the German government in the Bagdad Railway has led it to dispatch important missions to Armenia for the purpose of making archæological explorations in Armenia. The first of these expeditions was intrusted to Dr. W. Belck alone, and in 1898 and 1899 he was accompanied by the Assyriologist Dr. C. F. Lehmann. The report of these expeditions has just been issued, and the results to science are most important. The first indications of a civilization in the mountain-lands bordering on Lake Van were made known by the French traveler Dr. Schultz, who copied a number of inscriptions on the rocky walls of the fortress of the city of Van. Schultz, unfortunately, was killed by the Kurds, but his diaries and copies of inscriptions were recovered and published by the French government in the Journal Asiatique. Layard, who visited Armenia in 1849, copied a number of inscriptions, and Rassam, who made several visits to the country and excavated at Toprak Kaleh, the ancient palace of the Vannic kings, copied or took casts of several more, but the work of the German expeditions has greatly increased our knowledge of the country. The members collated all inscriptions previously copied, and increased the material for the study of ancient Armenian history by nearly two thousand lines—including the discovery of a most important and fairly lengthy bilingual inscription in Assyrian and Vannic. The most important result of the expedition has been to define clearly the extent of this empire, which had almost entirely disappeared from the field of history. The capital city was Van, on the lake of that name, called Dhuspas—the Tosps of the classics—but the royal residence seems to have been at Toprak Kaleh, called at a later period "Rusas town." The northern boundaries of the empire are uncertain, but several inscriptions were found in Russian Armenia. On the east the inscriptions were found as far as Lake Uromiyeh, and one on the rocky heights near Rowandiz, on the summit of the Pass of Keli-shin, 12,000 feet above sea-level. This inscription was first discovered by Sir Henry Rawlinson, and was set up during the joint reigns of the Kings Ispunis and Menuas, about B. C. 800. Westward, on the rocks at Palu, on the Euphrates, near Malatiyeh, the inscriptions of Menuas are also found.

ARCHÆOLOGICAL DISCOVERIES IN GREECE.

THE recent archæological discoveries in Greece and the islands adjacent have been so numerous that a proper understanding of their general significance has been rendered difficult. Interest is at present centered in the islands of Leucas and Ithaca, because of discoveries which may shed a new light upon the home and surroundings of Odysseus. From various parts of the country come reports of discoveries, although in many cases these are mere fabrications, and, when they are not, considerable difficulty is found in securing government possession.

A rather important field is being developed on the island of Crete. Seven tombs have been unearthed within the last few months bearing every evidence of Mycenaic origin and containing skeletons of men and women, marble statues, gold rings and bracelets, and various other ornaments and figures. One held a very remarkable carving in carnelian, rectangular in form, but slightly rounded on its long sides, and surmounted by two striking figures. The one represents a man in a kneeling position grappling a huge bull by the horns; the more remarkable of the two, however, is the figure of the Babylonian demon of the storm, the monstrous Typhon or Typhoon, after Assyro-Babylonian art, standing, with open mouth, upon its hind feet and holding aloft between its forefeet the figure of an animal. Upon its back it bears

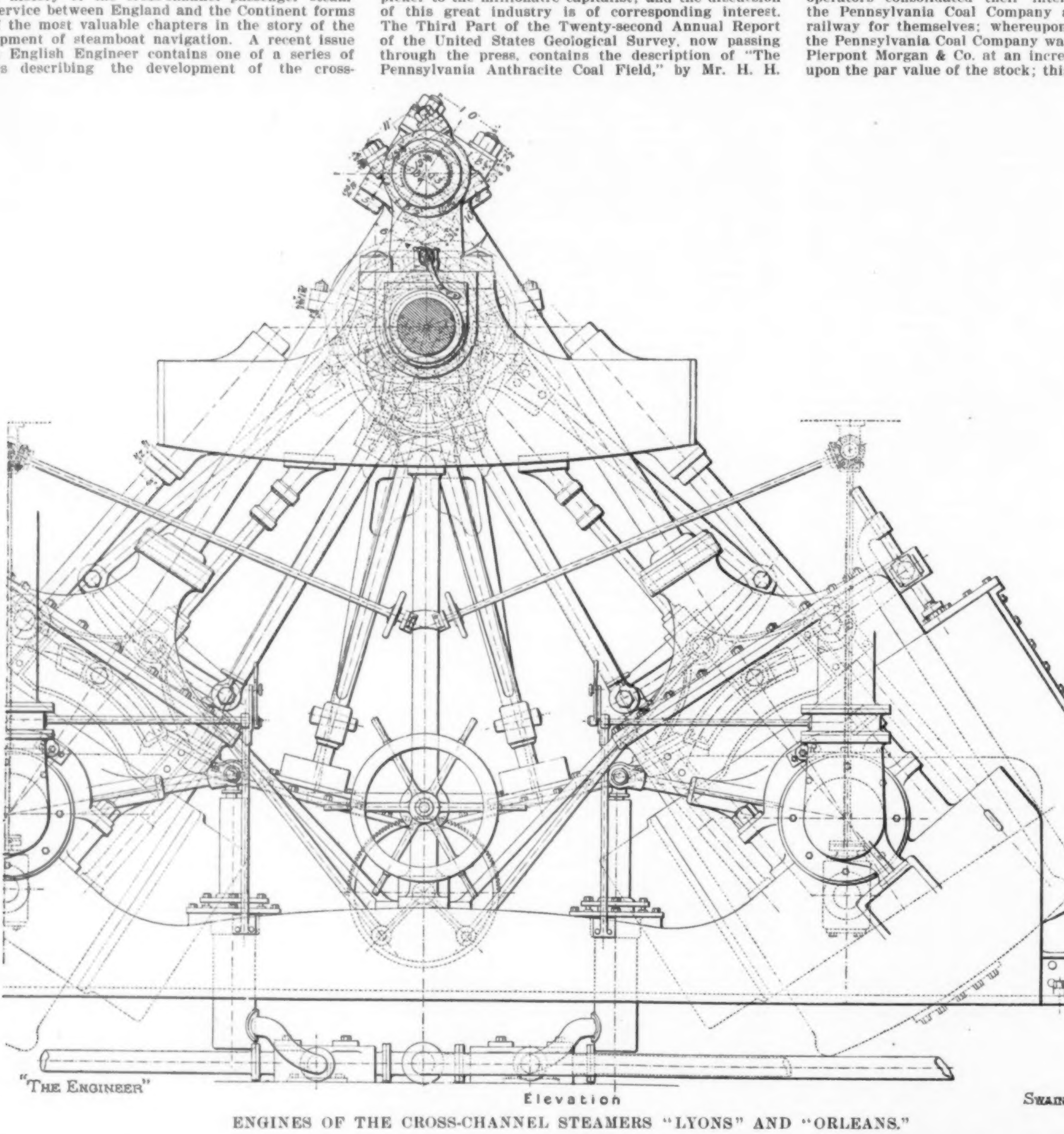
the heavy, fringed tunic of the Babylonian kings. This figure is considered of a high order of workmanship and very valuable.

Among other objects of interest found in these tombs were an earthen vase in the form of a wine pourer, the neck and mouth representing the head of a bird; a small bronze mirror; rectangular blocks of ivory surmounted by figures of mariners; and light, golden beads or bulbs, used as the medial pendants for necklaces and collars. The corridor leading to the tombs, cut out of solid rock, is 13 to 16 feet long and about 3½ feet wide, and the door leading into the tombs extends in an arch to the top of the passageway and is constructed entirely of hewn stone laid without mortar. The bodies discovered in each of the tombs are in a poor state of preservation, in most cases only the teeth remaining intact.

ENGINES OF THE PADDLE STEAMERS "LYONS" AND "ORLEANS."

The history of the cross-channel passenger steamship service between England and the Continent forms one of the most valuable chapters in the story of the development of steamboat navigation. A recent issue of the English Engineer contains one of a series of articles describing the development of the cross-channel passenger steamer, this article dealing particularly with the line from New Haven to Dieppe. The "Lyons" and "Orleans," which, with the "Alexandra," constituted the fleet of vessels engaged on this route at the time that it came under the control of the Brighton Railway Company, were of the following dimensions: Length, 189 feet 2 inches; breadth, 21 feet 8 inches; depth, 9 feet 9 inches. They were fitted with oscillating paddle engines, the cylinders being arranged in pairs diagonally and working on a common crank. The diameter of the cylinders was 48 inches, stroke 4 feet 6 inches, and the paddle wheels were 15 feet in diameter. The indicated horse power was low, being only 455. Steam was supplied at 30 pounds pressure per square inch from rectangular boilers. The speed of the vessels was 11¼ knots an hour. Each cylinder was fitted with but a single slide valve, and there was only one set of eccentrics to work the link motion of the two engines. We present an illustration, for which we are indebted to the Engineer, which shows a section of the engines taken through the condenser, which was of the jet-injection type with the air pump seated in it, the latter being worked by a separate crank on the paddle shaft. The boiler feed pumps, which were provided with trunk plungers, were worked by an eccentric fitted on the paddle shaft, as shown in this section, while the bilge pump rams receive their motion from a lever arm fitted on the cylinder trunnion.

The hand gear for controlling the action of the engines was very compact, all being within easy reach of the engineer in charge; but although this especial arrangement of engines was adopted with the intention of saving space within the ship it was practically a failure in the vessels so fitted. Both the "Lyons" and "Orleans" were built on Scott Russell's "wave line" theory as to form and were noted for their very fine entrance. They made the cross-channel passage from New Haven to Dieppe generally in about four hours and twenty minutes.



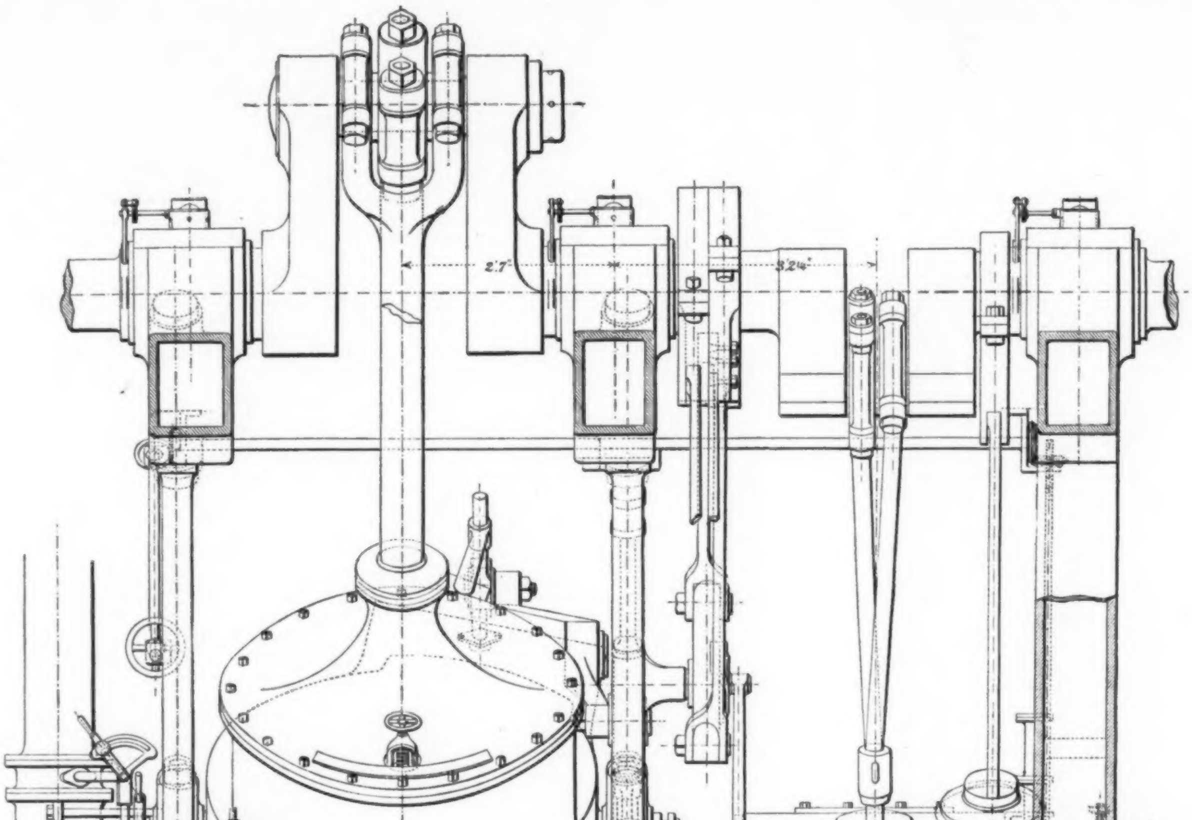
ENGINES OF THE CROSS-CHANNEL STEAMERS "LYONS" AND "ORLEANS."

THE PENNSYLVANIA ANTHRACITE COAL FIELD.

The good or the bad condition of the Pennsylvania anthracite coal-mining industry affects happily or unhappily the lives of hundreds of thousands of our people through all grades of society, from the coal picker to the millionaire capitalist; and the discussion of this great industry is of corresponding interest. The Third Part of the Twenty-second Annual Report of the United States Geological Survey, now passing through the press, contains the description of "The Pennsylvania Anthracite Coal Field," by Mr. H. H. Stoek. Speaking broadly, the anthracite coal field, consisting of long, narrow, upland valleys and located in east-central Pennsylvania, may be said to be bounded on the west by the Susquehanna River, on the north by the North Branch of the Susquehanna, and on the east by the Delaware and Lehigh Rivers. The anthracite region lies mainly within Lackawanna, Luzerne, Carbon, Schuylkill, and Northumberland counties, though the measures overlap into Wayne, Susquehanna, Wyoming, Sullivan, Columbia, Dauphin, and Lebanon. Of the total anthracite territory, only about 484 square miles are underlain by workable coal measures; this productive area is not continuous, but consists of detached basins. Of the four main geographic divisions, the Northern basin, including the Wyoming and Lackawanna valleys, contains 176 square miles. The Eastern-middle basin has a total coal area of about 33 square miles. The Southern basin extends 70 miles from Mauch Chunk on the Lehigh River west of Dauphin on the Susquehanna, and contains 181 square miles.

It is probable that only a very small part of the coal measures originally deposited in this region has escaped erosion. In the report of the Coal Waste Commission (Harrisburg), Mr. D. W. Smith estimates the original contents of the anthracite coal fields before mining began at more than 19,500 million tons, and he thinks that this amount of coal represents not more than 6 per cent, probably about 2 per cent, and possibly only 1 per cent of the vast original coal deposit before erosion took place. The development of the anthracite coal field may be briefly suggested by the following chronology: 1762, anthracite discovered in Wyoming Valley by Connecticut settlers. 1769, Obadiah Gore first burned anthracite in his blacksmith forge. 1802, anthracite first burned in a grate in Philadelphia. 1812, anthracite first successfully used in an iron furnace at Philadelphia. 1823, first cargo of anthracite shipped around Cape Cod to Boston. 1820-40, period of canals and navigation companies. 1840-1901, period of railroad exploitation. 1855, anthracite leads charcoal in manufacture of pig iron. 1887, important development of lake and western trade. 1900, large number of individual collieries bought up by railroads. After a protracted contest with the railroads, the individual operators consolidated their interests in 1899 with the Pennsylvania Coal Company and incorporated a railway for themselves; whereupon, in January, 1901, the Pennsylvania Coal Company was bought by Messrs. Pierpont Morgan & Co. at an increase of 752 per cent upon the par value of the stock; this property was then immediately sold to the Erie Railroad; and thus the contest was closed. The mining is by "stripping," where the coal outcrop can be easily reached, and by the room and pillar system for underground work. Slopes and shafts are the prevailing form of mine opening. Anthracite is universally mined with hand rotary drills and by the use of black blasting powder, dynamite or giant powder being sometimes used. The reports of the Bureau of Mines give 39.3 tons of anthracite mined as the approximate result per keg used, as against 282 tons, per keg of powder, of bituminous coal mined during the same period. The coal is not undercut as a general rule, and mining machines have never been applied successfully to the anthracite field. Ventilation is universally by rotary fans, and fire-damp exists in a number of mines in such quantities as to render it necessary to work them entirely by the use of safety lamps. Every known form of haulage—mule haulage, rope haulage, locomotive haulage—is to be found in the anthracite mines, there being in 1900 632 engines of various kinds, and 15,708 mules for hauling coal.

Unlike bituminous coal, anthracite must be broken, sorted to sizes, and have the impurities picked out, before it can be marketed. The coal is broken by toothed rolls, and screened in circular or horizontal



OSCILLATING ENGINES OF THE CROSS-CHANNEL STEAMERS "LYONS" AND "ORLEANS."

screens, the slate being picked out by machinery or by boys and old men. The cost of mining anthracite can hardly be given in general terms. It is probably not far from $1.50 per ton. Some years ago the anthracite miners were mainly American, English, Welsh, and Irish; but at present a great many nationalities are represented in the anthracite fields. The percentages of nationalities are about as follows: Americans, 21; Irish, 16; English, 5; Welsh, 9—a little over 51 per cent—Polish, 27; Hungarian, 6; Italian, 3; German, 4; and Austrian, Slavonic, Scotch, and Lithuanian over 1 per cent each. In 1899 the number of employés inside the mines was 92,223; of outside employés, 48,433, a total of 140,656. The production of coal in the anthracite field by decennial periods since 1880 has been, in round numbers: 1880, 28,700,000 tons, valued at $42,300,000; 1890, 46,500,000 tons, valued at $66,400,000; 1900, 57,400,000 tons, valued at $86,000,000. Concentration of interests in the anthracite coal fields has been the policy for the past few years in connection with the mining and preparation of coal, as well as in the ownership of the properties. Large central plants are rapidly replacing isolated smaller plants. One large breaker now does the work formerly done by a number of small ones. A single tubular boiler plant has replaced possibly half a dozen scattered individual plants of old-fashioned cylindrical boilers, and mammoth central pumping plants or drainage tunnels are now draining whole basins, where formerly a large number of small plants were doing the work. This concentration naturally tends to better management and to a saving in fixed expenses and in labor. These economies have resulted from the increase of capital and labor required to produce anthracite, without a corresponding increase in demand for it. In 1880 coal royalties were from 20 to 25 cents per ton for prepared sizes, the sizes below chestnut being neglected or thrown away; now royalties are 25 cents for pea coal, about 10 to 12½ cents for sizes below pea, and from 40 to 50 cents for prepared sizes above pea. In 1877, the average number of days worked per year was 205; 1897, it was 152. The cost of opening a colliery in 1887 was $100,000; now it is from $400,000 to $500,000. Owing to requirements of cleaning, about 14 per cent of the coal product which was formerly salable must now be thrown upon the dump. In 1887 the average daily breaker output was 500 tons; in 1897 the average of all breakers was 880 tons. In 1880, 88 per cent of the coal sold was of the size which was sold at a profit; in 1897, only 70 per cent. In 1877, 38 per cent of all coal mined was grate and larger sizes not requiring preparation for sale; in 1887, only 26 per cent; in 1897, 15 per cent. The selling price of prepared sizes at tidewater was $3.26 in 1877, $3.67 in 1887, and $3.46 in 1897. Deeper workings, heavier machinery, greater costs in many ways of mining, have greatly increased cost of preparation. Nevertheless, pessimists to the contrary, says Mr. Stoek, the anthracite industry, with an invested capital of some $700,000,000, with natural annual profits of from $85,000,000 to $100,000,000, with a freight traffic worth $40,000,000 per year to the carriers, cannot be rapidly wiped out of existence.

The coal beds vary in thickness from mere traces of coal to the 50 or 60 feet of the Mammoth bed. In the Wyoming basin of the Northern field 81.8 per cent of the total coal may be considered marketable; in the Eastern-middle field, 75 to 77 per cent; in the Southern field, 72 per cent; in the Western-middle field, 75 per cent.

TRADE BALANCE WITH GERMANY.

THE cordiality of the relations between the United States and Germany is shown eloquently by the commerce between the two countries during the last few years. These figures show that the commerce of the United States with Germany exceeds that with any other country of the world except the United Kingdom. This commerce has grown from $29,878,845 in 1865 to $292,226,329 in 1901.

An examination of the details shows that the percentage of increase in imports from Germany has been greater than the percentage of growth in exports to Germany, the figures being: Imports into the United States from Germany in 1865, $9,563,743; in 1901, $100,445,902. On the other hand, the exports from the United States to Germany were: In 1865, $20,315,102; in 1901, $191,780,427. Thus the imports into the United States from Germany are more than ten times as much in 1901 as in 1865, and our exports to Germany about nine and a half times as much in 1901 as in 1865.

Finished manufactures form the chief features of the imports into the United States from Germany, and foodstuffs and manufacturers' materials form the chief features of our exports to Germany. Sugar, chemicals, cotton manufactures, silk manufactures, leather and manufactures, toys, earthen, stone, and china ware, wool manufactures, iron and steel manufactures, and cement are the principal items in our imports from Germany, while raw cotton, corn, wheat, flour, pork and beef products, mineral oils, tobacco, oil cake and meal, naval stores, wood and manufactures thereof, and copper form the chief features of our exports to Germany. In a few classes of manufactures, however, notably iron and steel, the exports to Germany are considerable, but, as above indicated, the bulk of the movement from the United States to that country is composed of the articles required in Germany for food or manufacturing and which it does not produce in sufficient quantities at home, while, on the other hand, the bulk of the imports into the United States from Germany are foodstuffs not produced at home or the higher grades of manufactures, such as sugar, wines, coffee, rice, chemicals, gloves, laces and knit goods, woolen dress goods, silk dress goods, cutlery, porcelain and chinaware, and toys.

COMMERCE BETWEEN SPAIN AND THE UNITED STATES.

COMMERCIAL relations between the United States and Spain have been resumed with apparently greater cordiality and certainly with greater activity than ever before. The figures of the Treasury Bureau of Statistics show that both the imports into the United States from Spain and exports from the United States to Spain were, with a single exception, greater in the calendar year 1901 than in any preceding year. Our imports from Spain during the year ending with December, 1901, amounted to $7,040,758, and our exports to Spain were $16,785,711. Comparing 1901 with 1891, it is shown that our imports from Spain have grown from $4,906,475 to $7,040,758, and that exports to Spain from the United States have increased from $12,887,477 to $16,785,711. Comparing present conditions with those of 1898, it appears that our imports from Spain have increased from $3,608,308 in 1898 to the above-mentioned figure, $7,040,758; and our exports to Spain from $8,050,475 in 1898 to $16,785,711, as already stated.

This growth in the commerce with Spain is especially interesting at the present moment in view of the fact that our exports to many of the other European countries show a decline. In the calendar year 1901 our exports to Austria-Hungary, France, Germany, Greece, Italy, Portugal, Russia, Sweden and Norway, Switzerland, and the United Kingdom show a decrease as compared with 1900; while to Spain they show an increase from $15,200,917 to $16,785,711. On the import side, our imports from Austria-Hungary, Germany, Russia, Sweden and Norway, and Switzerland show a decrease, while those from Spain have increased from $5,382,662 in 1900 to $7,040,758 in 1901.

The exports from the United States to Spain are chiefly articles for use in manufacturing, cotton, lumber, crude mineral oil and tobacco being the principal articles in the list, by far the largest in the list being cotton. Our imports from Spain are chiefly fruits and nuts, wines, chemicals, corks and cork bark, and iron

ore of a special grade not readily produced in the United States. Lemons and oranges form a much smaller proportion of the imports now than a few years ago, due to the fact that citrus fruits are now largely produced in the United States. The importation of raisins has also greatly reduced in value, by reason of the increased production of raisins in the United States. Imports of preserved and other fruits from Spain have, on the other hand, increased, as have also those of almonds and other nuts.

RANGE-FINDERS.

By Prof. George Forbes, F.R.S.

Instruments for measuring the distance of an object by optical means are required not only by military and naval men, but by surveyors, by travelers, by sportsmen, by the mercantile marine, and by others. For each purpose there are special requirements as to the accuracy, range, and portability of the instrument. The instrument which I have perfected is the most difficult. It is intended only for military use, and only for one arm of the service. A time may come when I may adapt it for other purposes, but in the form now shown it is intended only for use with rifle fire. It is not suitable for long-range artillery, nor for the navy. The instrument before you looks simple enough, such as might be designed and completed in a month or two. But it has taken me ten years of intermittent, besides two years of incessant work and experiment and trial and alteration to arrive at the present simple and effective type, suitable for a single arm of the service. I may say, however, that this infantry type is by far the most difficult, because, in addition to accuracy, extreme portability is such an essential feature. At the same time the infantry are more in want of some addition to their present resources than anyone else, and the urgent want for such an instrument has been proclaimed and re-echoed by all our officers who have returned from the war in South Africa.

All methods of optically measuring the distance of an inaccessible object depend on using a base of known length, which must be measured on the ground, or else be part of the instrument. In the latter case the instrument can usually be worked by one man, who can find the distance without changing his position. This class of instruments is sometimes spoken of as short-base range-finders. Numerous patents for such instruments have been applied for; but the difficulties in the way of insuring accuracy are so great that only one type has ever been perfected and generally used. The Barr and Stroud range-finder has been adopted by the navy with most satisfactory results, and this has proved the fact that a short base (4½ feet) is not inconsistent with accuracy. But the Barr and Stroud instrument is as unsuitable for use with infantry as the instrument before you is for naval use. For the use of infantry, where extreme portability, and accuracy, and suitability for ill-defined objects, such as men, bushes, rocks, etc., are essentials, there is no instrument in existence which has ever been put forwarded as fulfilling the conditions, except the simple folding range-finder which I have to bring to your notice. In spite of all the tentative patents, it is noteworthy that this is absolutely unique, as no other short-base infantry range-finder exists.

Let us devote two minutes to noting the means by which we can find the distance of an inaccessible object, which may be any distance, and suppose it is to the north of us. Let us measure a base on the ground, east and west, 100 yards long, driving in a peg in the ground at each end of the 100 yards base. Let us have a table or drawing-board placed level at each of these pegs. Now we take a sheet of paper and draw a line, *A B*, one inch long, to represent 100 yards. Going to the drawing-table on the left we pass a needle through the point, *A*, and so pin it flat and level on the table. Then we turn the paper round, until a ruler, resting against the needle and lying on the line, *A B*, points along our base. Then keeping the paper fixed, we turn the ruler until it points to the distant object, and we draw a line, with pencil, on the paper along the ruler. We then go to the table at the other end of the base, and fixing the paper with a needle through the point, *B*, to that table, we go through the same operation and draw another line pointing to the distant object, *B*. The intersection of the two lines and the line, *A B*, on the paper, form a map of the positions of the distant object and of our base, on the scale of 100 yards to one inch. If the intersection be ten inches from *A* or *B*, we know that the distant object is 10 × 100 = 1,000 yards from either end of our base.

It is quite clear, now, that if we have a short base, say 6 feet long, then if we can measure the angle between two lines drawn from the distant object, one to each end of our base, we can determine the distance of the object from the base. All range-finders are founded upon this principle.*

The longer the base the more accurately is the distance found. With a base of 100 yards and a theodolite at each end of it for measuring the angles, the distance can be found with more than the accuracy required for any purposes of warfare. But the theodolites and their stands are heavy, and the instruments delicate; calculations must be made, time is required for the operation, and meanwhile the observers are attracting the attention of the enemy, and are perhaps in danger. For all these reasons the theodolite method is seldom practical, and simpler instruments, more portable, direct reading, easily and quickly used, with as little exposure as possible of the men, have to be devised even at some sacrifice of accuracy, to replace the engineer's theodolite.

With these considerations in view the Weldon range-finder and the Labbez telemeter and other pocket instruments were invented for use with a base that might be measured by pacing. These were followed by the mekometer, invented by Col. Watkin, which has long been the standard range-finder used by our army for infantry and artillery. The base varies from 25 to 100 yards, and consists of a string wound upon a reel when out of use. The range-taker and his assistant, after consultation as to the object to be sighted, proceed to the two ends of the base. The range-taker has a reading instrument, and his assistant has a right-angle instrument. The string being held taut, the assistant looks through his instrument and sees two pictures superpose, the object and the range-taker's instrument being both seen, one in each picture. He moves about until these are exactly superposed, and he tells the range-taker. If the range sought be that of a moving object the right angle man must move about all the time to keep his two points superposed. The angle at the end of the base where the assistant is must now be a right angle, and the range-taker looking through his instrument superposes the two pictures in the same way, not by moving about, but by turning a drumhead on his instrument which measures the divergence of the angle at his end of the base from a right angle. He then reads off directly by the scale on the drumhead the distance of the object. Col. Watkin invented a very neat drumhead and scale for doing this with the utmost facility. This beautiful instrument, though not so exact as a theodolite, can be made to work with all the accuracy that can possibly be required by choosing a long enough base. It appeared to me that besides having this instrument the effective power of an army might be increased by having an instrument which could be used by one man without changing his position, and, if necessary, under cover of a rock, a tree, or a wagon. It seemed that the necessity for consultation between the range-taker and his assistant might at times lead to confusion and error. It seemed that the parading of two men over the ground, while our skirmishers were concealing themselves behind cover, might sometimes be objected to. I have learned that all who have fought in South Africa agree that these difficulties do arise, and that the accuracy of shooting would be at least doubled if instruments such as I have to show you were in general use.

Prof. Piazzi Smyth tried to make a short, self-contained base telemeter for surveying, with a base of 60 inches, Col. Clarke 72 inches, Otto Struve used a base of 73.5 inches, and Adie one of 36 inches. All of these were failures. I am pleased to have discovered, and to be able to exhibit here, one of the few Adie telemeters ever made. It may be taken as the germ of all later attempts. Its faults are well known, and it is to the elimination of these faults that all subsequent inventors of this class of instrument have devoted themselves. It consists essentially of four mirrors at 45 deg. to the base, and a telescope in which two superposed pictures are seen of the distant object, one picture being seen by reflection from the two mirrors to the left in the diagram, the other picture being seen by reflection from the two mirrors to the right. Since the object is seen in a slightly different direction from the two ends of the base, the observer sees the object double in the telescope until he moves one of the mirrors so as not to lie at 45 deg. to the base. The angle through which he turns it is double the angle between the two lines coming from the distant object to the base, and, as we saw before, this angle tells him the distance of the object.

The mirrors are supported on an arm, and their weight bends it. Even the sun's rays will distort it, and the angle we have to measure is so small that the errors thus introduced destroy the accuracy of the instrument. The present Astronomer-Royal, Mr. Christie, used a screen for the sun's rays, and to this Messrs. Barr and Stroud added an arm so designed for strength that it does not bend by its own weight. All this makes the instrument very heavy, and not at all suitable for infantry use.

In looking at the diagram of the Barr and Stroud instrument you see that the two images are seen with one eye, hence the distant object appears to be double until the micrometer arrangement (a very ingenious one, consisting of a moving prism) has been so moved as to make a coincidence of the two images, when the scale reading of the micrometer gives the distance directly. It would be out of place to describe to you all the ingenious contrivances. I want now to direct your attention to this process of making a coincidence, upon which the accuracy of this and of most other attempted short-base range-finders depends.

Now in naval work, for which the Barr and Stroud instrument is made, a ship or its mast or funnel is very sharp against the sky, and the coincidence can easily be made; but this method is almost valueless in the field. A bush, or a rock, or a man is an object so ill-defined, especially against certain backgrounds, that in attempting to make a coincidence you may move one picture in the telescope over the other for a considerable angle before you are sure that it is double. An officer who used such a thing in South Africa said it was impossible, in most cases, to get any accuracy of coincidence, and deplored the fact that there were no steeples or masts on the veldt. Sir David Gill, of the Capetown Observatory, confirmed this, and Messrs. Barr and Stroud asserted that no range-finders could be invented to get over the difficulty.

The difficulty has been got over by Messrs. Carl Zeiss and by myself, who use stereoscopic vision. If you will look at the diagram of the Zeiss telemeter you will see that it resembles the one we have just examined in most particulars, but it has two eyepieces used with the two eyes. In the two focal planes also are two photographs on glass of two scales, the marks on one being at slightly different distance from the marks on the other. Each pair of marks has a distance, so many hundred meters, marked upon it, and a certain degree of convergence of the eyes is required to make any pair of marks appear single. The object aimed at also appears single with a certain muscular convergence of the eyes, and it is easy to pick out a pair of marks requiring the same convergence as the distant object, and you read off the number of hundreds of meters on that pair of marks directly. I will speak of the accuracy of stereoscopic vision presently. I now wish to say that if you are looking at an ill-defined object the two pictures leap together into one so soon as you concentrate your attention on them. This is true even if the object be out of focus or so feebly outlined as a cloud. It is the consequence of our spending our lives in working those eye muscles so as to make two pictures of an object appear as one. No muscles of the body are more constantly trained than those, and however faint the object may be the coincidence effected is absolute and immovable.

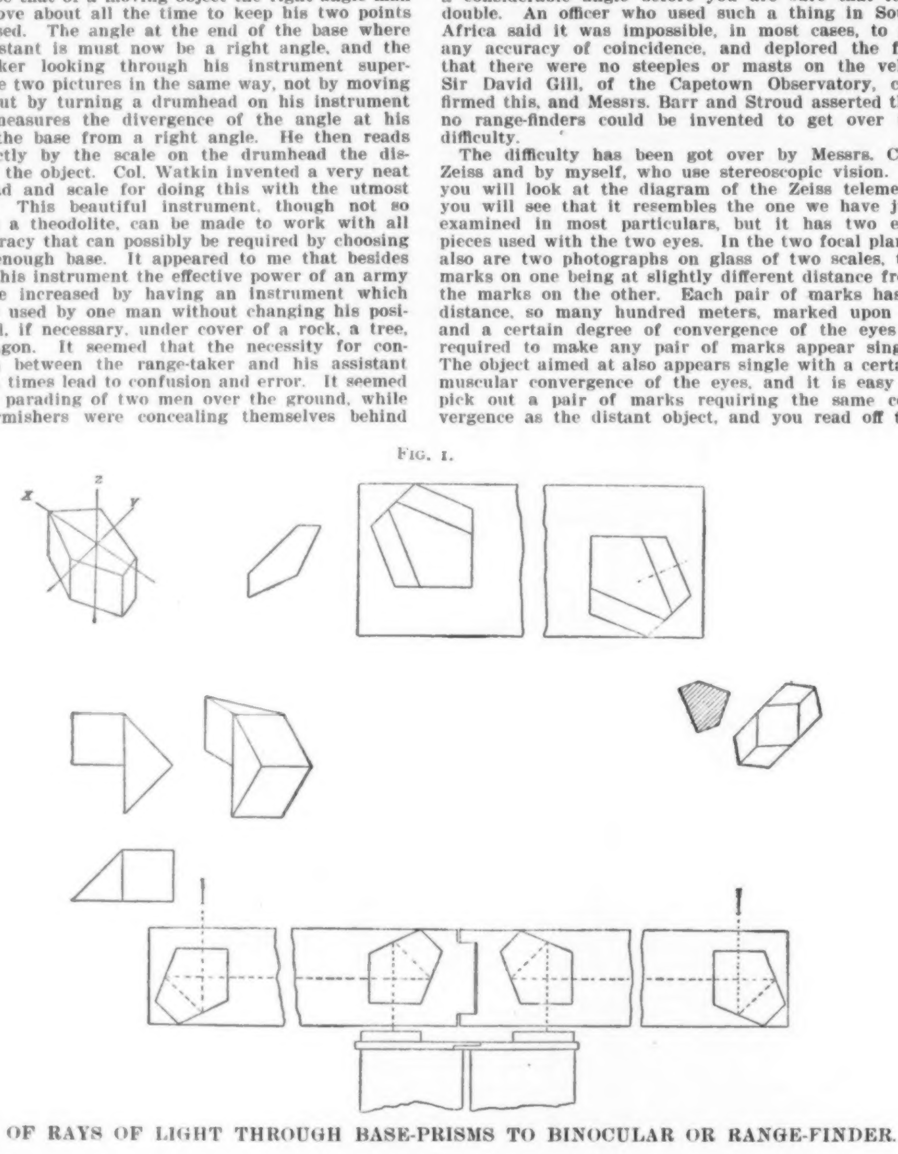
This physiological action is referred to by Sir John Herschel ("The Telescope," p. 118). In describing an arrangement of powerful telescopes for stereoscopic vision he says:

"When used for viewing near objects the mounting must admit of a slight convergence being given to the axes of the telescopes to direct them at once to the same object. If this be not done the object is seen double; but so soon as the images are brought very near they suddenly spring together, even while some minute deviation still subsists, in a very singular and striking way; while the sensation changes at once from that of contemplating a picture to that of viewing a real object."

This remarkable training, by which our eye muscles and our vision work automatically, hand in hand, is so remarkable that you will, I am sure, excuse me if I make a further quotation from the article, "Microscope," in the Encyclopedia Britannica:

"Comparing Wenham's device with those of Nachet and Riddell for obtaining stereoscopic effect with a binocular microscope, the author, after admitting that in the former the two images may be of different sizes and of unequal brightness, goes on to say: 'It is well known to those who have experimented upon the phenomena of stereoscopic vision (1) that a slight difference in the size of the two pictures is no bar to their perfect combination, and (2) that if one of the pictures be good, the full effect is given to the image, even though the other picture be faint and imperfect,

Fig. 1.



PATH OF RAYS OF LIGHT THROUGH BASE-PRISMS TO BINOCULAR OR RANGE-FINDER.

* If we are using, as I do, a base of 2 yards, then the angle at 3,000 yards distance is 2′.17″.5, and at 2,940 yards distance it is 2′.20″.3. This 60 yards difference of distance, which is 2 per cent of the distance measured, must be measurable on the range-finder for infantry use. So we must be able to measure the difference of angles or 2″.8, but the naked eye is generally assumed to be capable of perceiving 30″. So we require a magnifying power $\frac{30}{2.8}$, or nearly 11 times, to reach the required accuracy. For this reason I have used a magnifying power of 12. But with stereoscopic vision a far smaller angle than 30″ can be perceived with the naked eye, and a power of 8 gives me all the accuracy I desire, besides giving better illumination and easier manipulation.

provided that the outlines of the latter are sufficiently distinct to represent the perspective projection.' It might have been added that it is also well known that where both images are indistinct, as when a khaki-colored coat is observed against a sandy background, or when both images are slightly out of focus, the two images still leap together by involuntary muscular action of the eyes, and the axes of the two eyes are held fixed at the true convergence required for making a single picture out of the two images of the object viewed. Dr. Pulfrid has correctly stated that not only do indistinctly defined objects which cannot be clearly pointed out in the ordinary way—a distant fold in the ground, irregular bush, or the skirt of a wood—but also such things as a cloud of smoke or dust—absolutely without contour—so long as they detach themselves from the background, can have their distance determined stereoscopically as well as the most distinct object."

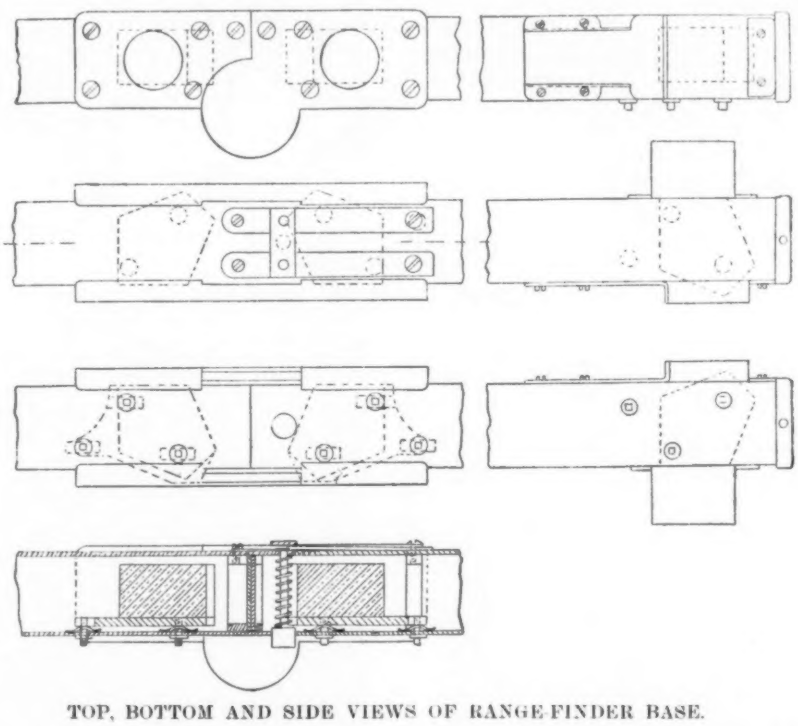
We started with the Adie telemeter. We saw how Christie overcame the warping action of the sun by a screening tube, and how Barr and Stroud gave such rigidity to the base that it does not bend, and we have seen how coincidence may be obtained in the two images of any object by stereoscopic vision as used by Zeiss. But even after these improvements we are a long way from having the portable instrument required for infantry which will not get out of order, and to obtain this we must adopt entirely different methods of getting over the difficulties in order to reduce weight and to overcome the following troubles: (1) While single reflections are used at the ends of the base, it is very difficult to maintain their position accurately, and an error of 10 seconds deflects the ray of light through 20 seconds. (2) Where the base forms the telescope tube with the object glasses at its extremities their displacement deflects the image in the focus. (3) To overcome the bending of the base to a few seconds of arc it must be very strong and too heavy for portability. (4) Even so, with the Zeiss instrument, the zero of the instrument must be set before each observation, and by fixing these firmly on a moderately rigid base, no adjustment of the base is required to insure accuracy unless it meets with a serious injury. The binocular, which is a separate instrument, and which contains the measuring devices, is the only part of the range-finder that requires occasionally testing, and this can be done with the utmost ease, as will be explained when I speak of the adjustments.

The diagrams here exhibited will assist in understanding the description which I now give.

The instrument consists of a folding aluminium base 6 feet in length and a field glass. The base is a square tube hinged at its middle and folds up to 3 feet 6 inches. Each half has at each end a doubly reflecting prism. The rays of light from a distant object strike the outer pair of these four prisms, are reflected at right angles along each tube, and are then reflected at the two middle prisms into the two telescopes of the binocular fixed to the base in directions parallel to the original rays intercepted by the outer prisms. It is the measurement of the angle between these rays that tells the distance of the object looked at. This angle is measured by two vertical wires, one in each telescope, seen by the two eyes. One of the wires is fixed, the other is moved by a micrometer screw until the two wires appear as one, while the object is seen distinctly. This gives the distance accurately to 2 per cent even at 3,000 yards. But now stereoscopic vision comes in and gives far greater accuracy. The wire seems to stand out solid in space and the slightest turn of the micrometer screw causes the wire to appear to be nearer or farther than the object looked at, and when the wire appears to be at exactly the same distance the micrometer reading gives the distance with an accuracy far greater than that attainable by observing the duplication of images on the retina.

I have spoken of wires in the focal planes of the binoculars, but I have given these up. I will tell you why. If I adjust the vertical wires crossing the field of view until they seem to be at the distance of any object, say a tree, then the lower part of the wire differs for an object on the level and another higher above it. (5) The setting of the instrument is very difficult.

FIG. 2.



TOP, BOTTOM AND SIDE VIEWS OF RANGE-FINDER BASE.

I will now show how I have got over all these difficulties. (1) At each end of the base where the ray is to be reflected through a right angle I do it by two reflections from two surfaces, absolutely fixed to each other at an angle of 45 deg. (2) I use stereoscopic vision and make the binocular telescope independent of the base. And (3) this enables me to have a hinge at the middle of the base which doubles its portability.

I find that the double reflection is best accomplished by using glass prisms. The diagrams show the path of the rays, and examples of the prisms are exhibited. Some of these have total internal reflection, others have silvered surfaces. The latter make the most convenient form of instrument, though they lose more light. With these prisms the ray of light is deflected through a right angle, and a pair of prisms if set fairly parallel sends the ray into the telescope quite parallel to the direction in which it entered the end of the base. In my instrument I could not allow an error of 2½ seconds of arc in the extent of the deflection of the ray in the plane of vision. To give so great an error one of the prisms must be displaced with respect to the other through an angle of 18 minutes of arc. It is very easy to prevent such an error in the setting of the prisms.

If I used the base for telescope tubes as others have done, there could be no hinge in the middle, for if the hinge did not work with mathematical accuracy the position of the focal image would change. With my arrangement if the two halves of the base be not in a right line still the rays entering the telescopes must remain parallel to the rays entering the extremities of the base, and it is the angle between these which measures the distance.

By the use of solid glass prisms for the double reflections, whose surfaces are immovably related, and cutting the foreground ought to be also at the distance of the tree. But common sense opposes this view, for the foreground is nearer than the tree. Thus the stereoscopic sense, if I may use the expression, believes itself deceived, and refuses to work so readily. To obviate this I next used a line coming from the top vertically down to the center of the field. This got over the difficulty entirely. Then I thought out a way of getting over another difficulty. We are not accustomed to see wires or lines in the sky or landscape, and we do not find the same tendency for them to "spring together," as Sir John Herschel describes it. The only real object I could think of with a point at its lowest part was a balloon with a tail-rope, the lower end of which is at the center of the field. This has been a grand success, and the two balloons spring together even with observers who could never bring the lines to look like a pole at a fixed distance. Almost everyone can now get the stereoscopic effect easily.

There are not many men of science who have tested the accuracy of stereoscopic vision. All who have done so are aware that the stereoscope is the most accurate means of measuring an angle that we possess. Dr. Wolfe, of Heidelberg, has a stereoscopic comparator for detecting the motion of stars from photographs taken at different dates.

With this instrument I have stereoscopically observed some of the stars lying in a direction at right angles to the sun's motion in space by means of two photographs taken at an interval of four years. The nearer stars appear, with this gigantic base, to stand out distinctly nearer than the others in the stereoscope, although no micrometer with the same magnifying power could detect the parallax. It cannot be doubted that the naked eye can stereoscopically detect an angle of less than ten seconds.

The stereoscopic method has also this advantage, that the muscles of the eyes are being trained by us every hour of our lives to make two pictures of an object appear as one. Hence when you look even at an ill-defined object the muscles compel the two images to jump together.

I may mention that the wonderful accuracy of stereoscopic visions was first discovered by Prof. Dove, of Berlin (Optische Studien, Berlin, 1859, pp. 26 to 36). As examples: he found that in a stereoscope the eyes were able to detect the difference in size between a bronze and silver medal struck from the same die. On being examined, one with each eye, the resulting form appeared always to be curved, and not flat; also two impressions of printed matter from the same type seldom failed to show some of the letters advancing in front of or receding behind the plane of the paper. Prof. Helmholtz, in his physiological optics, has emphasized the same fact.

I had a good illustration of it when describing my range-finder to a scientific audience. One speaker said he did not believe in the accuracy of stereoscopic vision, and gave the reason as follows: "There is a blind in front of the window there with a cord. Holding my head steady, I tried to judge its distance from the window frame. I put it at 2 inches, but now I see that it is 6 inches distant." He was about 24 feet from the cord, and we may take 2½ inches as the distance between his eyes. The angle subtended was 28′.56″. But he thought the distance was 24 feet 4 inches, the angle subtended being 28′.30″. So that in this first rough essay he was able to measure the angle correctly to 26 seconds of arc, a very accurate estimate, instead of being inaccurate, as he thought it was.

I have had an excellent opportunity of testing the accuracy of stereoscopic vision. I adjust the micrometer screw until the balloon in the focal planes appears to be at the same distance as some clear object against the sky. The observation is repeated ten times and the maximum difference between any two of the ten readings amounts to less than one second of arc with a magnifying power of twelve. This means a maximum error of half a second, or six seconds with the naked eye. An accuracy to half a second is far closer than I have sought for, my limit being 2.8 seconds to give 2 per cent at 3,000 yards. Thus my instrument is five or six times more accurate by the use of stereoscopic vision than I require. I am, therefore, diminishing the magnifying power of the binoculars to eight instead of twelve, and even then I can confidently say that in the hands of an average man viewing an average object the range-finder will give the distance correct within 2 per cent at 3,000 yards. I have put the instrument to the severest tests, and am ready to welcome the strictest trials of its accuracy. Moving figures, badly lighted objects, and even the targets at Bisley when they were dancing with mirage, have given distance measurements that exceeded the standards I had aimed at.

My base is 6 feet long, and folds to 3 feet 3 inches, and in carrying I find it best to strap it on the back. It weighs from 2½ to 3 pounds.

I have had many binoculars made, and at last have arrived at the beautiful solid scientific engineer's instrument which Messrs. Carl Zeiss, of Jena, have made from my designs, and which I now show you as the regulation type which I think ought to be adopted for infantry. Its optical qualities, used apart from the base, are superb. Used with the base, its indications are absolutely reliable, and it is strongly built and suitable for rough service. It weighs 2½ pounds.

The instrument can be used with only half the base, in which case the readings of distance must be halved. This is sometimes desirable in a gale. In this case you are viewing the object direct with one eye; this gives you a larger field and higher illumination, which qualities are at times useful.

This is not the place to describe the theory of the hinge, which few people have appreciated; nor the mathematical theory of the adjustments of the base. These are very easily made owing to the manner of mounting the prisms each on three screws working against springs. These adjustments need never be touched when at work on the field. If one balloon appears higher than the other a touch to one of the screws sets it right. The base cannot get out of adjustment, so as to give a wrong reading, unless it has met with a serious accident. Then the adjustment can be made in camp in half an hour.

It is necessary, however, to have a simple means of adjusting the micrometer scale of the binocular, as the zero may become displaced—or, rather, what we call the infinity point. The construction of my range-finder does this. The binocular, when attached to the base, can be moved up to view the object whose distance is required without using the base. The balloon is set to the same distance, and then the index, which is movable on the scale, is set to the infinity point of the scale. The binocular is now lowered, and the distant object viewed through the base, and the balloon set to agree as to distances. The scale distance is read off, and 1-30th deducted (the base being 30 times the distance between the object glasses). This gives the true distance. If, now, we move the index till it points to this true distance without turning the micrometer, then the instrument is set and will give directly the true distance of any other objects.

This range-finder can be used in a variety of positions. The more steadily it is held the more accurate the result. A standing position is the least steady. When kneeling, using only half of the base, the other half may be bent down at right angles, and so form a leg which serves as a rest on the ground. The most easy position is sitting with the elbows resting on the knees. Another steady position is lying flat on the ground facing the object. In every one of these positions you can take advantage of cover. Since your eyes are virtually at the extremities of the base you may stand, sit, kneel or lie behind a tree, bush, rock, ant-hill, horse, comrade, or wagon; and you will not only be more able to work without sensation of danger, but your comrades who are seeking cover will not abuse you for exposing yourself, and drawing on them the fire of the enemy.

Let us look now at the value of such an instrument. I have been assured that if my range-finder does all I claim for it, and if each company had one such instrument, then the effect of shooting would be doubled. One hundred men would then be doing the

work, as fighting men, of two hundred, a gain, at £100 per annum, a soldier's cost to the country in peace, of £10,000 per annum per company. Supposing, then, that the instrument were to cost one-third of the 4½ foot-base instrument used in the navy, or £80 (and it is probably less), then for every £80 of capital spent, the army is receiving interest at the rate of £10,000 per annum.

I have had advice and encouragement from many whose authority no one could dispute. It is upon their advice that I fixed upon my standard of accuracy and other requirements for an infantry range-finder. I have satisfied myself that the accuracy asked for is more than attained. But I eagerly asked for opinions as to general convenience from a soldier's point of view. These, I am glad to say, have all been favorable. Sir George Clarke, before he left Woolwich to take up his appointment as Governor of Victoria, was good enough to inspect its working, and gave me his opinion on these points. He wrote to me: "It seems to me that you have an excellent form, ideally portable, and extremely convenient." Then, after stating the degree of accuracy that he considers desirable, and saying that facility of learning to use it is essential, he adds: "Another point is durability in the field. Here, again, I do not think that an instrument can be made which will not require some special care in handling, and I think that your range-finder is perfectly satisfactory in this respect."

After receiving such expressions of opinion from such an authority, to whom I was a stranger, I felt it my duty to spare no effort to perfect the instrument made on these lines.

But the greatest encouragement I have received, which satisfied me that I was working on the lines required by those who are experiencing the want of such an instrument in actual warfare, came from Lord Kitchener at Pretoria, who, after seeing photographs of the instrument used in various attitudes, and after reading a detailed description, communicated with me to express his interest in my range-finder and his desire to have one in South Africa, and undertaking among his multitudinous duties to see that the range-finder be thoroughly tested.

Such a test in actual warfare would be more severe and more crucial as to the special claims I make for this instrument, and more satisfactory to all of us who desire that the army should be raised to the highest efficiency than any tests that could be made at home. I am more than ready, I am anxious, to submit my range-finder to this test, and have replied to Lord Kitchener that I hope to make all arrangements immediately to enable me to proceed to South Africa to assist him in testing the instrument in the way he has indicated, and I have arranged to start in a few weeks' time.

I have not attempted to decide how the range-finder shall be clothed and fitted up. I mean whether it should be covered with leather to look like a shop instrument, whether it should be in a leather case to carry on the back, or should be worn as a sword, etc. I have produced, after showing my models of various dates to most competent authorities, a type which I am satisfied is the best that the sciences of optics and mechanics can give to fulfill all the requirements. I could give you greater accuracy at the sacrifice of portability, or greater portability at the sacrifice of durability in the field, or greater field of view and illumination at the cost of convenience in handling, or greater rapidity of working at the risk of making errors. But I cannot give you an instrument which meets all these requirements more fully, in proportion to their importance, than the range-finder which I humbly submit this evening to your notice.—Journal of the Society of Arts.

SCIENCE IN THE THEATER.

As soon as sufficient progress had been made in electrical science to permit of obtaining light in a sure and practical manner, the Chatelet Theater at once installed the apparatus necessary for its production, that is to say, a steam engine and dynamos. Later on, when, after the burning of the Opera Comique, electric lighting was made obligatory for all theaters, a genuine plant was installed under Place du Chatelet for supplying the two municipal theaters that stand opposite. But now that conductors of electric energy are numerous in Paris, private plants are not needed, and the theaters are connected with the station that supplies the quarter. The result is that theaters, being no longer allowed to use boilers, sometimes find it difficult to produce certain scenic effects in which jets of steam are needed. Such a case presented itself at the Chatelet in the piece now playing called the "Voyage de Suzette," and in which there is a boat which, in order to add to the illusion, appears on the stage whistling and allowing clouds of steam to escape. M. Judic, one of the directors of the theater, who at the same time is a skillful electrician, has solved the problem of steam without a furnace by installing upon his boat a boiler heated by an electric current (Fig. 3). This has a capacity of 12 gallons and rests upon a wooden frame which is easily transportable. It is provided with a whistle, siren, and pressure gage, and all the other usual accessories. The bottom is provided with ten apertures upon which are mounted tubes about 14 inches in length closed at the upper extremity, but open at the lower. In this way there has been constructed a sort of tubular boiler, the heating surface of which is constituted by the exterior of the tubes. Into each of them is introduced, by friction, a fireclay cylinder surrounded by a spiral of German silver wire covered with asbestos cardboard. This constitutes what is called a "candle." The two extremities of the spiral end upon the frame at a terminal which may be connected with the electric main. As soon as the current passes, the wire, which offers a great resistance thereto, is raised to a red heat and remains in this state as long as may be desired. Commutators permit of putting one or more candles in service at will. At the outset, they are all employed at once; and, as each candle consumes 4 amperes, the total number of amperes is 40. Under such circumstances, it requires about an hour and a half to obtain a pressure sufficient for the supply of the whistle and siren. After the pressure has once been obtained, and in the interval between the scenes in which steam is employed, the latter is kept up by leaving only one or two candles in circuit.

It is probable that many other theaters will have occasion to employ this boiler, and that it will form a part of the material of every well-equipped stage.

In the same piece, M. Judic has had occasion to utilize the electric current in another manner for giving the spectator the illusion of a cascade of precious stones—an illusion accomplished by a very ingenious arrangement. From a mass of rocks situated in the distance escapes a sheet of water represented by a curtain of a light fabric containing wires of Dutch metal. Stones of all colors, diamonds, topazes, rubies, emeralds, etc., scattered over the whole breadth, seem to fall from the top of this cascade, which is 16.5 feet in height by 23 in width (Fig. 1). This effect is obtained by means of 1,000 colored incandescent lamps placed behind the fabric representing the sheet of water. These are fixed, one under another, to the number of 50, upon 20 bars of wood arranged vertically, one alongside of the other, for the entire width of the cascade. Upon lighting each lamp of the same bar, for an instant and in succession, and beginning at the top, a perfect illusion of a waterfall is obtained. The lighting and extinction are effected by means of a special commutator placed in the wings, and which may be seen represented apart in the upper right hand corner of the accompanying engraving.

All the lamps of the same bar are connected with a circle of contacts, arranged upon a board, and an arm closes the circuit of a lamp when it passes over the corresponding contact, but breaks it as it passes over the next contact to light the following lamp. The boards are placed one above another and connected by rods. The whole system is firmly attached to a light strip and is traversed by a shaft provided with a handle that permits of giving it a rotary motion. Upon this shaft, by means of a collar, is fixed the arm that closes and opens the circuit upon the contacts of each board. It will be seen that, according to the position in which the arm is secured to the shaft, it is possible to effect the first lighting wherever it may be desired. In the case under consideration, care is taken not to begin with all the lamps of the upper part at the same time, but, on the contrary, to vary the starting point on each bar, in order to produce the illusion of stones detaching themselves from the current of water at hazard. By adding a second arm for each board, it is possible to light two different points of each bar at the same time. It suffices to unscrew the collar and to screw it up again in order to

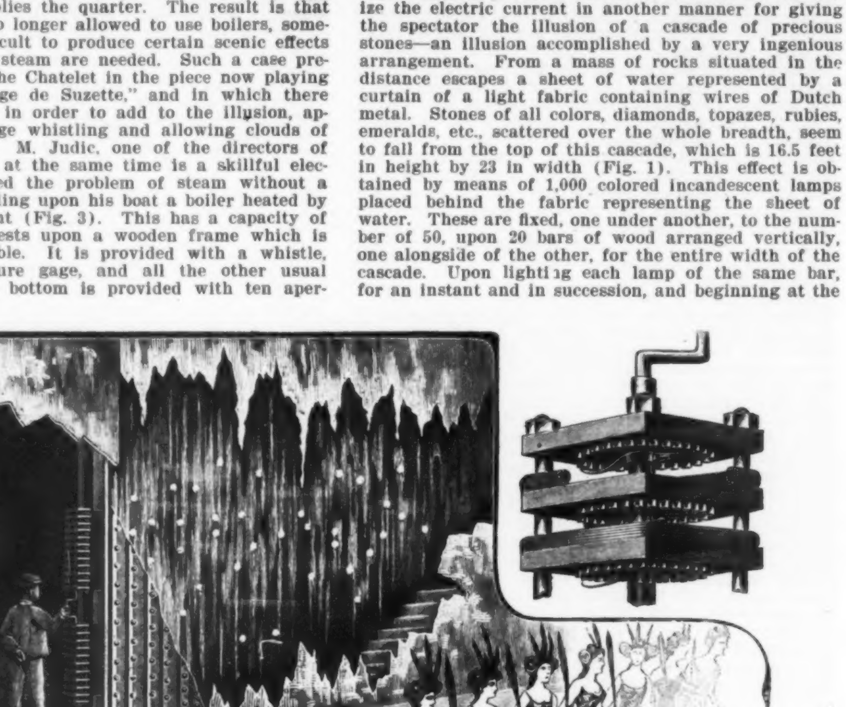


Fig. 1.—THE CASCADE OF JEWELS IN THE "VOYAGE DE SUZETTE," AT THE CHATELET THEATER, PARIS.

Fig. 2.—THE LUMINOUS JEWELS, ELECTRIC EQUIPMENT OF THE BALLET DANCERS.

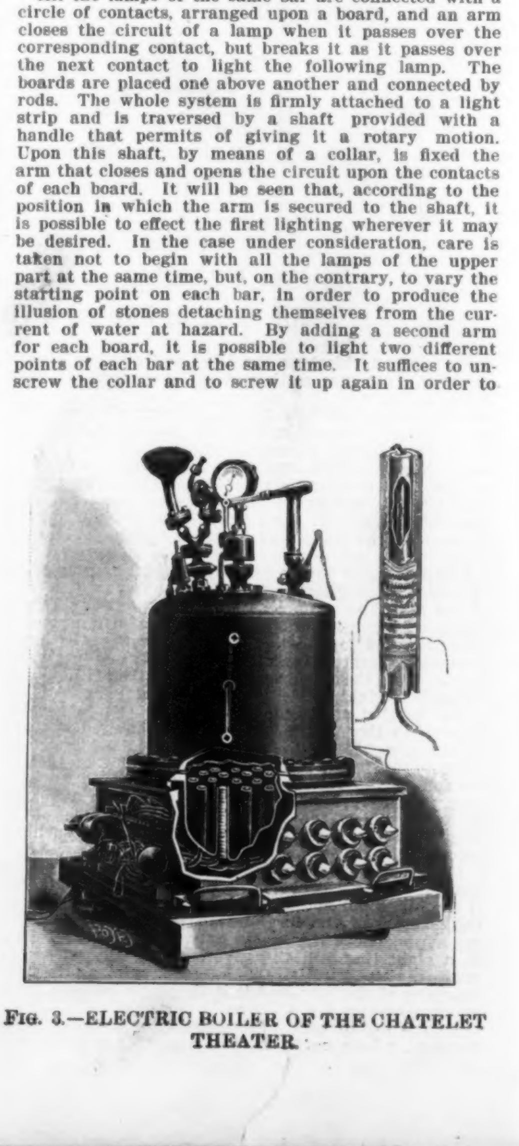


Fig. 3.—ELECTRIC BOILER OF THE CHATELET THEATER.

set the arms at any desired point, and thus permit of producing manifold combinations. It should be remarked that by changing the direction of revolution it is possible to produce the effect of an ascent instead of a fall of the water. This might be utilized for giving the illusion of fireworks. In order to obtain a brighter light, M. Judic employs 75-volt lamps, although voltage is 110. There is no inconvenience in this, since each of the lamps remains lighted for but a fraction of a second; but, as the operator might accidentally stop the handle when moving the switch arm over the contacts, M. Judic has provided a general interrupter which the machinist keeps constantly closed by drawing upon a wire, but which would open spontaneously should he let go of it.

This apparatus operates perfectly, and has been very successful not only in Paris, but in London, where the inventor has recently been called upon to apply it at the Drury Lane Theater.

Finally, in order to complete the application of electricity to the stage, a ballet has been mounted in which each of the 60 danseuses carries ten incandescent lamps arranged upon their costume and in their headdress. This had already been done, especially at the Opera, but upon a smaller scale. Here the effect is much more complete.

Groups are formed, each personifying a different precious stone, and the lamps are consequently colored with a transparent varnish. It required a certain amount of research to obtain the desired effect, since the light under the varnish gave rise to many surprises. The desired result was obtained only by the use of globes of ground glass. The lamps, which are for 4 volts, are connected in circuit with a small two-element accumulator which the danseuse carries in a rubber bag (Fig. 2). There are two circuits—one for the head-dress and the other for the costume. Both are connected with a switch placed within reach of the hand, which closes the current upon a first pressure and breaks it upon a second. The sixty danseuses illuminate themselves or extinguish the lamps at determinate moments, and the effect is very pretty. Flexible wires terminating in plugs permit of quickly connecting each circuit with the accumulators. The latter are charged during the day through the intermedium of a special distributing board. All the members of the ballet, just before going upon the stage, assemble in the wings to get their equipment, and this presents a very curious scene (Fig. 2).

It will be seen that electricity is utilized in various forms at the Chatelet Theater; and, with a director likewise an electrician, we must expect still further applications of it.—For the above particulars and the illustrations, we are indebted to La Nature.

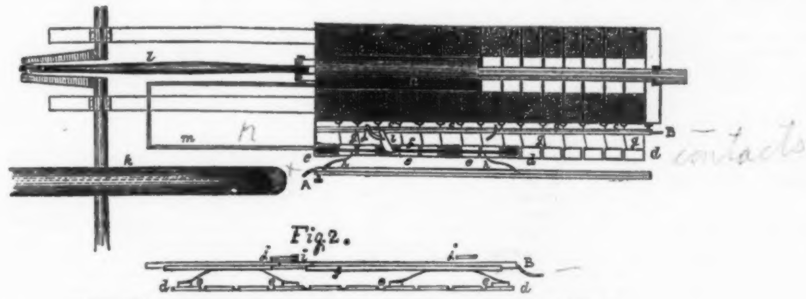
EARLY FORMS OF ELECTRIC MOTORS.

AN invention may be ever so new and startling, and yet in outward form it will nearly always resemble some previous device. The adherence to type is one of the most curious phenomena in the psychology of invention. In the early days of the railroad the cars used were merely horse-coaches, fitted with iron wheels and placed on rails. Even the seat of the driver was reproduced in grotesque miniature. Not until the railway car was lengthened in order to increase its carrying capacity was the old type abandoned. To this very day we still see traces of the turnpike coach in the peculiar roof of the railway-car. And thus it is with the automobile. We still cling to carriages used by our forefathers for hundreds of years; and, strive as we may, it seems impossible to depart from the traditional pattern. Our automobiles are exactly what we call them—"horseless carriages." So inadequately is their design adapted to their motive power that we feel the want of horses.

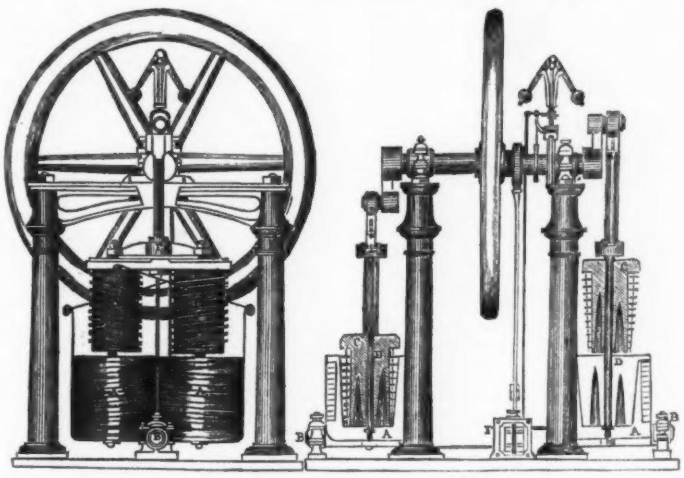
An interesting confirmation of this singular adherence to type is to be found in the development of the electric motor. Turning over the pages of the SCIENTIFIC AMERICAN we found in the volume for 1851 a few illustrations of motors which were justly looked upon as wonderful contrivances in their day, but which to our modern eyes seem quaint adaptations of the principles of steam engineering to electric engineering.

These early electric motors were almost without exception designed on the lines of reciprocating steam engines. One of the first seems to have been that of Davenport, a Vermont inventor, who used a walking-beam engine with metal pistons moving in magnetic coils, forming each an entire hollow cylinder.

Dr. Page, one of the pioneers in the field of electromagnetism, following in the footsteps of Davenport, designed a motor that, at first sight, might well pass for a reciprocating steam engine. It had not only what corresponded to steam cylinders, but also a flywheel, a walking-beam, and almost every electrical equivalent of the parts of a steam engine. Page employed solenoids in which a piston-like core, *a*, moved, as shown in the accompanying top plan view. This electro-magnetic piston drove a double crank and thus a flywheel, *k*, through the medium of a connecting-rod, *l*. An arm, *n*, attached to one side of the rod, *l*, acted as a cut-off. The positive wire, *A*, and the negative wire, *B*, connected the solenoid with the battery. Small blocks, *d d*, were connected with the solenoids by wires, *g g*, forming the connecting points of the circuit, and therefore performing a similar office to the ports of a steam engine. A slide, *f*, carried by the arm, *n*, was provided with two thin strips of copper, each of which carried two metal spring plates, *e e*, in permanent contact with some of the copper blocks, *d d*. As the slide moved back and forth the circuit was completed alternately from coil to coil, cutting off the current behind and throwing it on ahead. In order to throw the current from one half of the coils to the other half, a so-called "stroke changer" was used, serving to reverse the stroke. The changer, *i*, was pivoted on a center pin and arranged to strike one of two dogs, *j j*. When the changer struck one dog it caused one set of slides, *e e*, to form the circuit, and when it struck the other dog it turned on its pin and touched the strip of copper attached to the slides, *e e*. Whenever a full stroke was made the changer at once diverted the current from one half of the solenoids to the other, the three coils near the middle being first charged, and so on, one after the other, as the piston moved along. A stroke of any length could thus be given to the piston. Page claimed that, with the friction brake, his engine would give eight horse power. The writer of the article in the early number of the SCIENTIFIC AMERICAN referred to is rather skeptical. He very properly thought that friction-brake tests are not always true tests. Although he did not deny that the motor was practical, he thought that the steam engine would still hold its own. Conservative as he was, however, he thought that Page had "produced



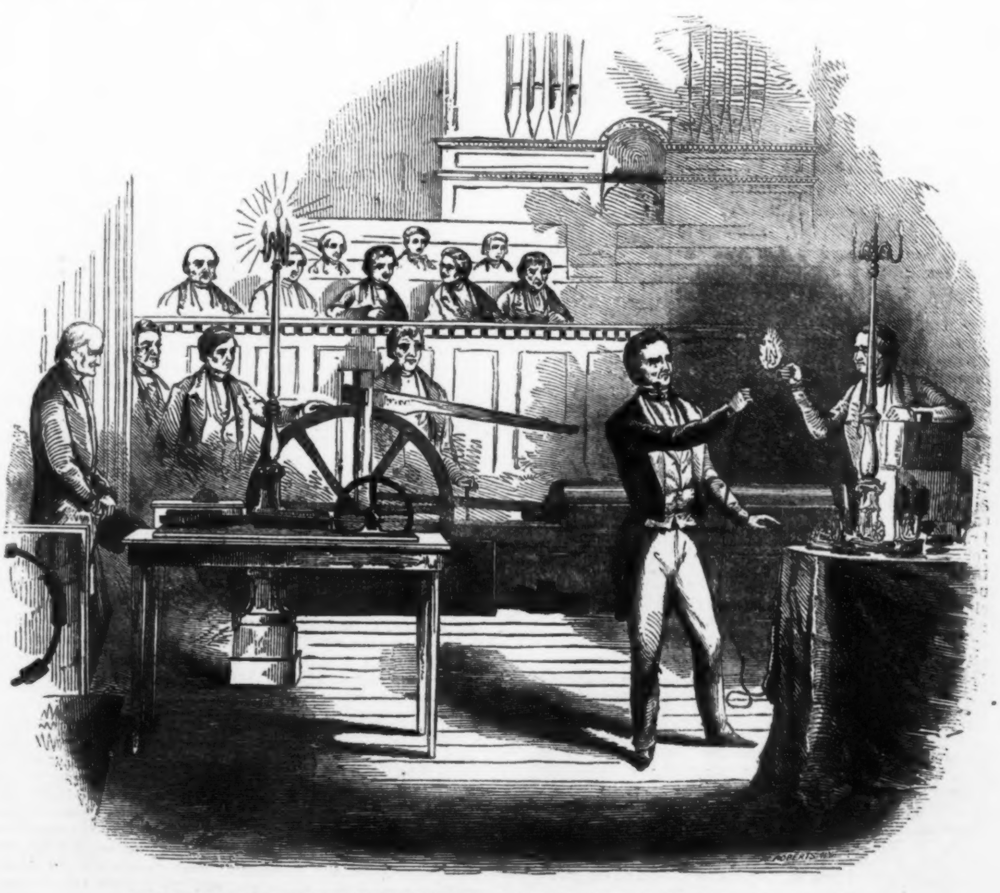
TOP PLAN VIEW AND DETAIL OF PAGE'S MOTOR.



SIDE AND END ELEVATIONS OF HJORTH'S MOTOR.

the most perfect electro-magnetic engine ever built, and future improvements, if they can be made (and who doubts it?) may yet bring it to be the compact motor so desirable for aerial navigation, and without which no such art can be rendered practicable."

Davenport and Page were not the only ones who were strongly influenced by the traditions of steam engineering. Soren Hjörth patented a motor in 1849, which was awarded a gold medal at the London Exposition of 1851. Hjörth employed electro-magnets, *A A*, conically hollowed and mounted endwise on trunnions, *B B*, on which they oscillated. Electro-magnets, *C C*, conically shaped on their exteriors, glided on guide-rods, *D D*, and imparted their motion to the flywheel shaft through the medium of cranks. Extensions within the hollow magnets, *A A*, fitted in corresponding recesses of the magnets, *C C*. The motor was provided with a commutator resembling the slide-valve of a steam engine, and, like the latter, was operated by an eccentric on the motor-shaft. This contrivance directed the current to one or the other of the two groups of electro-magnets. The attraction exerted by the magnets, *A* and *C*, was more powerful than had been obtained before Hjörth's time, owing to their peculiar construction. When one movable magnet reached the end of its motion the commutator turned the current from the group to which it belonged into the other, so that the magnet, *C*, in the first set was moved up and the magnet, *C*, in the second group down. The engine could be reversed by the use of a supplemental eccentric. A ball governor served to regulate the proper supply of electric current to the commutator. Hjörth's electric motor was, therefore, an electrical reproduction of a reciprocating steam engine of the oscillating type.



DR. PAGE'S EXPERIMENTS WITH HIS ELECTRO-MAGNETIC MOTOR.

CONTEMPORARY ELECTRICAL SCIENCE.*

Automatic Mercury Pumps.—G. W. A. Kahlbaum communicates the fruits of ten years' work with his automatic mercury pump, which he first brought before the scientific congress at Halle in 1891. The pump is built on Sprengel's principle, and works with one fall-tube. The substitution of several fall-tubes for the single one does not offer any perceptible advantages which would not be obtained by lengthening the single fall-tube. The author has personally tested all the 150 pumps designed for scientific use, and finds that 30 of the best exhaust, on the average, down to 0.5 mm. pressure in 3 minutes, to 0.000165 mm. in 15 minutes, and to 0.000069 mm. in half an hour. One of the best performances on record is that of Raps's pump, which exhausted 400 cc. to 0.001 mm. in 6 minutes. The speed of exhaustion solely depends upon the correct relation between influx and efflux of the mercury. This relation must be separately fixed for each pump. It is quite impossible to prevent the mercury taking up and carrying along minute air bubbles, especially if it is brought into intimate contact with the air for 600 hours in succession—the record time for continuous working. But, against all expectation, the author found that this is no drawback, as it does not tend to impair the vacuum created.—G. W. A. Kahlbaum, Ann. der Physik, November 11, 1901.

Deformation of Alternate Currents.—A simple apparatus for exhibiting the deformation of alternating currents has been devised by Robert Weber. It seems to be invented for the purpose of avoiding the necessity of using Braun's cathode ray tubes, and consists of a kind of combined telephone and sensitive flame apparatus. A polarized electromagnet is made of a steel magnet 25 cm. long and a straight electromagnet in such a manner that the wire of the latter overlaps on the former, with the two axes coinciding. Facing the core of the electromagnet is a box, such as used by König in his experiments on sound. The membrane which closes the box is provided with a small armature of soft iron, and the outer surface of the box is provided with the usual gas jet. An alternating current passing through the electromagnet produces vibrations of the armature and membrane, and makes the flame sing. The singing flame can be photographed in the ordinary manner, and the deformations of the current curve appear on the negative. The author reproduces some fine photographs obtained from currents with various capacities and inductances.—R. Weber, Ann. der Physik, November 11, 1901.

Electric Polarization Balance.—F. Maccarone has devised an instrument for showing the polarization of dielectrics and dielectric viscosity. It consists essentially of two equal plane, horizontal, circular disks of brass with holes in the center. Between the disks is suspended a glass beam with a bifilar suspension. Two glass disks (microscope cover glasses) are attached to the ends of the glass beam, with their planes vertical. Two other glass disks are mounted in a fixed position within the orbit of the suspended disks. The oscillations of the beam are made perfectly aperiodic by means of a magnetic damping arrangement. The entire suspension weighs 0.6 gramme. The whole apparatus is placed under a glass cover and kept dry by means of sulphuric acid. On connecting the upper brass disk with the earth and charging the lower one from the battery of condensers, a uniform electric field is created between the two disks, and a gradually increasing repulsion is observed between the movable and the fixed glass disks. The repulsion only attains its maximum after a considerable time. On discharging the upper disk, the beam returns to its normal position, but very slowly. The fact that it does return fully to its normal position shows that no hysteresis proper exists. The author gives a mathematical explanation of the repulsion which, however, is only complete when the repelling bodies are ellipsoids. The apparatus may be used for determining the dielectric constant of any body which can be obtained in four equal fragments.—F. Maccarone, Physikal. Zeitschr., November 15, 1901.

New Dip Circle.—The Lloyd-Creak dip circle for observations at sea is a device for applying Lloyd's needles for the purpose of determining dip and total intensity at sea, as devised by Capt. Ettrick Creak before his recent retirement from the superintendence of the compass department of the British Admiralty. The instrument represents so many modifications on the old Fox dip circle that it may appropriately be given a new name. It has been supplied to both the English and the German Antarctic expeditions. The back circle and other parts of the usual Fox circle have been done away with and replaced by thick ground glass. There is but one graduated circle marked to every 10 min. instead of to 15 min. as in the Fox circle. The microscopes (faced with ivory) crossed with single wires are turned as usual with the circle until the wires cut the points of the needle, when the degrees and minutes are read directly where the wire cuts the circle. Should there be motion in the ship a mean of the oscillations on each side of the wire should give good results. The axles of the needles are the same as in the Fox circle, but the upper half of the jewels is removed to allow the non-reversible needles for intensity and the reversible dip needles to be taken in and out. A lifter is provided to lock the needles when not in action. In other respects the circle is used as are Barrow's circles fitted with Lloyd's needles for land observations. The instrument is specially intended for high values of the total intensity.—Terrestrial Magnetism, October, 1901.

Electric Dispersion.—Some interesting observations of the dispersion of negative and positive electricity have been made by G. Rachmanow on the steep southern side of the Crimea. The observations were made by means of an apparatus as used by Elster and Geitel. The author determined the ratio of the dispersion of negative electricity to the dispersion of positive electricity at various elevations and under various circumstances. The highest value of the ratio found was 3.17. It was found at a height of 1,187 meters above the sea, 5 miles from Yalta. The apparatus was in the shadow of a house. At Yalta itself, at an elevation of 10 meters, and with the instrument in full sunlight, the ratio was 2.29. When the instrument was placed under the shadow of a shelter the ratio became unity. A peculiar observation was made at a waterfall situated between Yalta and Ai-Petri, at 370 meters above the sea. The ratio observed there was 0.16, which shows that positive electricity was dispersed six times faster than negative electricity. It appears that at the higher altitudes and in the sun the number of positive ions exceeds that of the negative, but in the neighborhood of a waterfall the number of negative ions is the greater.—G. Rachmanow, Terr. Magn., October, 1901.

Radiation at Low Temperatures.—The law of cooling at low temperatures has not been much studied up to the present. The experiments of Dulong, Petit and Desains were made with a blackened copper ball 2 cm. in diameter, suspended by a thermo-couple in the center of a glass bulb 8 cm. in diameter. These experiments have been carried down to the temperature of liquid air by M. Compan. The bulb was exhausted by means of a mercury pump provided with six fall tubes. After exhaustion the copper ball was heated without removing it from the bulb by concentrating upon it the light of an arc lamp. The temperature thus obtained could be brought as high as 320 deg. The bulb was then plunged successively into melting ice, into a pasty mixture of carbonic acid and ether, and into liquid air. The interior of the glass bulb was not blackened, since it was found that the emission of the glass was equal to that of lamp-black at the low temperatures. The author found that Stefan's formula best interpreted the rate of cooling observed. According to this formula the rate of cooling is proportional to the fourth power of the absolute temperature of the cooling body and of its envelope. Weber's formula does not apply to the low temperatures, but fits better between temperatures lying between 100 deg. and 300 deg. The formula of Dulong and Petit only applies between 0 deg. and 200 deg., the calculated rate of cooling being otherwise too high.—Compan, Comptes Rendus, November 18, 1901.

Use of the Thermopile.—Henri Becquerel indicates a new method of applying the thermopile, the use of which for the determination of temperature was proposed by his grandfather in 1826. The method used by the elder Becquerel for determining underground temperatures at the Natural History Museum of Paris was the following: One terminal of an iron-copper couple was brought down to the level to be measured, the other was immersed in a bath whose temperature could be varied and accurately measured by means of the mercury thermometer. The temperature of the bath was so adjusted that the galvanometer deflection became zero, and when that happened the temperature of the bath was the same as the underground temperature to be measured. The author now uses a different method, which he calls that of the sliding scale. If the junction in the laboratory is kept in ice, a galvanometer, such as that of Deprez-D'Arsonval, will indicate the temperature of the other junction by this deflection, which is practically proportional to the difference of temperature. That being the case, the author does not consider it necessary to keep the junction in ice. He simply leaves it at the ordinary temperature, and slides the scale of the galvanometer until the latter at its zero reading indicates the temperature of the room. On closing the circuit the galvanometer then gives directly the temperature of the other junction. To avoid unequal heating a high resistance should be given to the galvanometer.—H. Becquerel, Comptes Rendus, November 18, 1901.

Dielectric Strain.—A dielectric placed in an electric field is subjected to a tension along the lines of force and a pressure at right angles to them, and it is to be expected that it will show an elongation in the direction of the force. Such an elongation has been shown to exist by the experiments of Righi and Quincke, but it is much too large and probably is not due to the dielectric stress at all. Cantone has also obtained elongations, and measured them by the displacements of interference fringes; but these, again, have been placed in doubt by the results of L. T. More, who used a tilting mirror for his measurements and found no measurable elongation. The Italian school admits that this negative result says a great deal for the accuracy of More's work, but that his method was not sensitive enough to discover the small changes of length required by theory. L. T. More now maintains that his limit of observation was one-quarter of a scale division, but when the glass tube was subjected to dielectric stress there was no deflection either on charge or discharge. Theoretically there should have been a deflection of 3.5 divisions. The author points out that Cantone took no adequate precautions against that most troublesome source of error, the bending of the tube by electrostatic attraction, and still maintains that the effect actually found is not as yet the true phenomena.—L. T. More, Phil. Mag., November, 1901.

Resistance of India Rubber.—A. W. Ashton has made an attempt to ascertain what relation exists between the resistance of different dielectrics and the E. M. F. at which the resistance is measured, and also what effect is produced on the insulating properties of india rubber by the continued application of a high alternating pressure. It appears that Para rubber, which is the kind generally used in the manufacture of cables, is more easily attacked by ozone or other gas generated by the action of alternating stress on the air than other kinds of rubber. This decomposition has, however, only been detected when there has been comparatively free access of air to the rubber. In the case of the rubber called No. 1 by the author, although it was kept for 3,000 hours under an alternating stress having a maximum value of 50,000 volts per cm., no deterioration in insulating properties could be detected, but the fact that this rubber becomes harder and rather brittle on keeping makes it unsuitable for cable work. The principal conclusions arrived at are: that in the case of the okonite cable the current during the first hour's electrification increases as the charging pressure increases; that this does not necessarily prove the dielectric not to follow Ohm's law, since the true conduction-current must be considerably less than the total current unless electrification is continued for very lengthened periods; that in the case of the okonite cable and the paraffine-paper condensers, the charging current is a power-function of the time reckoned since electrification commenced, and on this may be superimposed a current of true conduction; that for the okonite cable, the mica, and the paraffine-paper condensers, the discharging current is a power-function of the time which has elapsed since discharge began, the currents at any particular charging pressure, but varying time of charge being given in case of the okonite cable by equations of the form

$$e = K\left(\frac{t}{K_1}\right)^{-x}$$

where $x - X = K_2 T^{-z}$; $t =$ time in seconds since discharge commenced, $T =$ time of charge in seconds, and K, K_1, K_2, K_3, and z are constants.—A. W. Ashton, Phil. Mag., November, 1901.

Lines of Closest Fit.—In plotting curves to connect a number of points yielded by experiment the usual plan is to draw the line that seems to give the general trend of the data. But the draughtsman's judgment is not much of a guide after all, and a more rigorous method is very desirable. K. Pearson has devised a mathematical method, at least, for straight lines and planes of closest fit. He proves, first of all, that the best-fitting straight line for a system of points in a space of any order passes through the centroid of the system, and coincides in direction with the least axis of the ellipsoid of residuals. The plane of best fit passes through the line of best fit, and is perpendicular to the maximum axis of the ellipsoid of residuals. These lines and planes may also be considered in relation to the ellipses and ellipsoids which arise as "contours" in correlation surfaces. Then the best fitting line for the system of points coincides in direction with the major axis of the correlation ellipse, and the mean square residual for this line is = (product of standard deviation)/(semi-major axis of correlation ellipse).—K. Pearson, Phil. Mag., November, 1901.

Oscillograph Observations of Sound.—A. Blondel has improved his oscillograph so as to make it available for studying the transformation of sound vibrations into electric oscillations by means of the microphone and intensifying current. The improved oscillograph is bifilar, and gives a deflection of several millimeters per milliampere. It was used for studying the singing arc lamp, and the author reproduces several diaphragms corresponding to the five chief vowel sounds. They clearly show that the well-known characteristic curves already established by other methods have certain superimposed vibrations of a frequency about 15 times that of the fundamental vibration of the vowel I. Since the oscillograph was perfectly damped, the author is driven to the conclusion that the ternary current which he used emits an oscillation of that small period itself. It can be got rid of by inserting a resistance, but at the cost of amplitude. It is remarkable what very slight variations of the E. M. F. are able to produce large oscillations in the current strength of the arc. The variation may, according to the author, be exaggerated from a few per cent to 100 per cent, and since the volume of the gaseous mass of the arc varies nearly in proportion to the current, it is easily conceived that its rapid vibrations produce loud sounds, and this explains the intensifying action of the arc.—A. Blondel, Comptes Rendus, November 11, 1901.

*Compiled by E. E. Fournier d'Albe in The Electrician.

ELECTRO-CHEMICAL WORKS AT NIAGARA.

The Electro-Chemist gives the following interesting data: The present total output of electricity at Niagara is about 50,000 horse power; of this no less than 23,200 horse power is consumed in electrolytic and electric-smelting operations. This power is distributed as follows:

	Horse power.
Electrical Lead Reduction Company	500
Acheson International Graphite Company	1,000
Pittsburg Reduction Company	5,000
Carborundum Company	2,000
Matthieson Alkali Works	2,400
Niagara Electro-chemical Company	500
Ampère Electro-chemical Company	300
Union Carbide Company	10,000
Oldbury Electro-chemical Company	1,000
Roberts Chemical Company	500
Total	23,200

Cassier's Magazine also gives some interesting statistics in connection with these works. The Electrical Lead Reduction Company reduce lead from its sulphide in the form of sponge, principally for the manufacture of litharge. The original alternating current at 2,200 volts is used for induction motors, which in turn drive direct-current dynamos which generate current at 100 volts. The Acheson International Graphite Company convert anthracite into graphite in the electric furnace. The current is used at 80 volts pressure. The Pittsburg Reduction Company, it is needless to say, extract aluminium from bauxite by the Hall process. The two-phase alternating current, which enters the works at 2,200 volts, is converted first to 130 volts and then by rotary converters, each of 600 kilowatt capacity, to direct current at 160 volts. The Carborundum Company produce silicon-carbide in 110-volt alternating-current electric-furnaces. The Matthieson Alkali Works transfer the 2,200 volts two-phase current into direct current at 230 volts. They produce chloride-of-lime and caustic-soda by the Castner process. The Niagara Electro-chemical Company convert their current into direct at 165 volts for the production of sodium and sodium-peroxide from caustic soda. The Union Carbide Company work their electric-furnaces (200 horse power each) at 110 volts and 25 alternations. According to Cassier, this company probably uses more electric-power than any other one factory in the world. The Roberts Chemical Company use direct current at low voltage for the production of caustic potash, etc.

THE POSSIBILITIES OF COLOR PHOTOGRAPHY.*

THE dream of reproducing all the varied and wonderful coloration of nature by means of photography, remarkable indeed as recent progress has been, is perhaps as far from realization as ever. With the single exception of the Lippmann process, hedged about with technical restrictions, and, in its result, necessitating an abnormal method of viewing, none of the many systems of color reproduction can be called in any sense direct. We can all admire without stint the exquisite effects obtained by the ingenious and beautiful method due to Ives, or the more mechanical and less complicated devices of Joly and Sanger Shepherd, but, however practically useful and satisfactory for their purpose they may be, they still, alas! fall short of the longed-for ideal, which shall make every photographer his own painter, no longer in monochrome, but in the glorious tints and harmonies of reality. It must be admitted that, compared with the striking development of photography in general, since its first beginnings, rather more progress might have been expected in this direction. Curiously enough, people were more sanguine of a successful solution of the problem of color photography even thirty or forty years ago than the majority are now. It would be superfluous to quote those early prophets of the coming triumph of photochromy. Charles Kingsley's well-known apostrophe in "Two Years Ago" is only one among many. But progress in this direction seems rather to have damped the ardor of experimentalists than otherwise. The subject has been seen to be more complicated than was at first imagined, and a better comprehension of the mysterious laws governing color sensation and vision has led to a greater degree of respect and hesitation among those who approach the matter. Then, too, it is really remarkable how comparatively little interest is taken by the majority of photographers in what should be to them a most fascinating quest. It is not difficult to imagine how different would have been the attitude of the early pioneers of photography—keen experimentalists and lovers of their art as they were—if they had but known as much as we now do of the theories and latent possibilities of photography in colors. Nowadays, we are too fond of taking a "thus far and no farther" for granted, and resting on our oars contentedly, basking in the light of other men's experience and failures, and refusing to be drawn into what we regard as a doubtful and unremunerative pursuit, foredoomed to lack success.

Why, it is often asked, should experiments in this direction be confined to the few, clever of intellect and perfect in technique though they be? Is it not a saddening reflection that the successful British workers in, for instance, the Lippmann process may be counted on the fingers of one hand? Why cannot our multitudinous photographic societies take advantage of such a splendid field for independent original experiment and research as the whole subject undoubtedly affords? Some time ago an experimental class was suggested and formed at a well-known London Polytechnic for the purpose of encouraging photographic investigation and study in new directions. As a result, it may be remembered by some, several decidedly interesting and helpful facts were elucidated. If so much resulted from the gathering together of one small band of workers for one brief session, it is easy to imagine how vast might be the benefit if societies in general were impregnated with the experimental spirit, and set out to discover and prove things for themselves, rather than pursue an acknowledged and beaten track. The scope for inquiry and experiment is truly remarkable. Let us endeavor, at the outset, to obtain a clear and definite idea of what we really desire to attain in order that photography in natural colors may no longer be a dream of the future, but a practical and practicable actuality. We require, then, a process or means by which a positive picture in the true colors of nature may be obtained with one exposure on one plate or other receiving surface; the exposure to be as rapid as that possible with ordinary plates. Or, a means by which a negative in complementary colors can be secured, and a paper or other surface capable of reproducing from this negative, by means of direct printing, any number of prints in natural colors.

So much for the requirements of the ideal, and non-existing, process; it remains to be seen how far the systems we now have in use satisfy these desires, and in what directions they are, or may be, capable of improvement. First, let us consider the Ives process. This highly beautiful and elaborate product of the perfection of scientific thinking and unbounded patience depends essentially on the taking of three negatives answering to the three fundamental color sensations. It therefore, unfortunately, however practically successful and useful, fails to make any contribution to the solution of our problem. It, however, certainly affords us a brilliant illustration of the success with which three distinct images can be synchronized, with perfect and accurate registration, a point of much value, as we recognized on many previous occasions. Next we will turn our attention to the much-discussed Joly process, with its finely ruled taking-screens. When all is said and done, there is perhaps no avoiding the conclusion that the lines, however fine and minute, are distinctly distracting and objectionable. Well, here is room for the experimentalist. Let some one devise a screen composed of extremely small dots instead of lines, so microscopic as to draw no more attention than the grain of a plate now sometimes does. That being done, and it is quite within the range of possibilities, we should be a long step nearer our goal, as a very little thinking will show. There still remains the necessity for the viewing screen, however, and, in so far, the process cannot be described as a really direct method of photochromy. And it is difficult, with our present knowledge, to foresee any means by which this objection may be overcome. The Sanger Shepherd process labors under the same disadvantage of not being a truly direct method of translating color, although both theoretically and practically it possesses many merits. It does not, however, contribute in any way to the solution of our problem, nor give us any helpful suggestion that may act as a finger-post on the road.

All things considered, the Lippmann process is, as we said before, the nearest approach to a realization of our ideal, and is well worthy of the most attentive and minute study. It is perhaps on the lines of this system, and as a natural development from its fairly well understood principles, that the future conquest of our present difficulties may be looked for. There is abundant scope for the independent investigator who is willing to expend time and patience on this process, and perhaps the satisfaction of effecting some great and striking improvement. After all, how much lies buried in mystery that may be brought to light in the future! What secrets may be lurking in that eccentric compound of so-called red silver chloride that has worried the brains of many a bygone scientist! Was Carey Lea nearer to the goal than he dreamed? Who shall say? Becquerel, too, and Charles Cros; has their work received quite the amount of attention it deserved? We want to clear our minds of prepossessions and prejudices, and pet scientific theories, and give rein to a little sheer empiricism for awhile; patient investigation and experiment, whether we see our way clear or not, are the golden qualities that may bring a rich reward.

* From the British Journal of Photography.

AN IMPROVISED SPECTROSCOPE.

SOME students may find useful information in an article by S. E. Dowdy, in the Pharmaceutical Journal:

"To anyone interested in the subject the following instructions for making a small spectroscope at a nominal cost may be of use. The finished article, which will be nearly identical in theory and principle of construction with the modern instrument used for the purpose, will serve to demonstrate the method of working with a spectroscope, and will show the more conspicuous spectroscopic phenomena, such as the bright line spectra of lithium, sodium, etc. The requisite materials for putting it together will cost about 2s. or 3s., and will comprise a prism, a small wooden box, a cardboard tube, and one of the small toy telescopes, a few inches in length, used by children. Starting with the box, a cigar box will answer capitally; first remove the lid, then cut out from the middle of the bottom of the box a narrow slit, about 2 inches long and ½ inch wide. Over this slit place an ordinary microscope 3 by 1 inch glass slide, cementing it down with coaguline, so that the slide will form a kind of window in the bottom of the box. On the outside of the slide now gum two pieces of dead-black paper, with perfectly parallel sharp-cut edges, separated by a small space, so as to form a narrow slit. The top of the box must now be knocked out, the box itself stood upright on the table, and a candle placed in the back of it, with its flame on a level with the slit in the glass slide.

"The glass prism, which can be purchased for a few pence at any optician's, is now mounted end up in a piece of cork, which is glued to a block of wood of sufficient height to bring the prism level with the slit. If one of the edges of the prism be now placed nearly opposite the slit, on looking sideways through the prism a narrow continuous spectrum will be observed. Viewed in this way, however, this spectrum will be too narrow to be of any practical use, and this is where the elaborate apparatus turned out by the optician evinces its superiority over the improvised article by the greater breadth given by it to this primary image of the spectrum on viewing it through a telescope, magnifying it about eight diameters. An adaptation of this method can be utilized by taking a cardboard tube, about 14 or 15 inches in length, and inserting in one end of it the small telescope previously referred to. The whole cardboard tube can now be mounted on a block of wood or any improvised stand that will bring it to a level with the spectrum. If the open end of the tube is now placed close against the prism, in such a position that a clear view of the spectrum is obtained in the center of the field of the telescope and in sharp focus, the apparatus will be ready for use.

"For the candle, which emits white light and, therefore, gives a continuous spectrum, now substitute a spirit lamp or Bunsen burner, the colorless flame of which gives no spectrum. If a trace of a volatile salt, such as sodium chloride, lithium bromide or potassium bromide, be introduced into the flame on a piece of platinum wire, bright lines corresponding to the metals present will be observed in various sections of the spectrum. For experimental purposes the above-mentioned metallic salts are about the best, as they all give conspicuous lines—sodium an intense yellow, the well-known D line, lithium a bright line in the red, and potassium a well-marked line in the violet. Of course, the construction of a piece of apparatus like the above may be modified in several respects, but there are certain essential features which must be included, the chief of which are, first, the slit between the prism and the source of light must be very narrow, and have parallel edges; second, the telescopic tube must be capable of rotation round the prism so as to get a better view of the various parts of the spectrum; third, the prism itself must be in the position of minimum deviation; and, lastly, as much extraneous light as possible must be cut off from the spectrum by having the telescope tube close up to the prism."

THERMOMETER GLASS AT HIGHER TEMPERATURES.

ACCORDING to W. McClellan, who writes in the Journal of Franklin Institute, the range of mercurial thermometers at the upper limit is sometimes increased by filling the tube, above the mercury, with nitrogen, and so, by increasing the pressure, raising the boiling point of the mercury. A thermometer used for some time in the metal pot of a linotype machine showed an alteration of 17 deg. in the reading, and this led to the present investigation. The gradual alteration of the zero of glass thermometers is well known, and is due to the slow dissipation of tensions in the glass, imperfectly removed during the first annealing. Wiebe has found that Jena normal thermometer glass showed a rise of 0.04 deg. in the zero-point during 285 days, and that Thüringen glass showed six times and English glass four times as much when at the normal temperature, while at 360 deg. C. the Jena glass zero rose 2.21 deg., and that of the Thüringen glass 7.3 deg. in 19 hours. He also found that of ordinary thermometer glass and "fine annealed" glass, the latter was by far the more constant. Baryta-borosilicate 122 III. glass appeared, from his experiments, to be the best for thermometers. The author's observations on the gradual change of zero, when plotted on a curve, show that the alteration is at first rapid, and that, as the tensions are removed, the rate of alteration gradually decreases until the zero at last remains practically constant. The period at which this point is reached, varies inversely with the temperature. Experiments have shown that a good thermometer glass may be heated to about 600 deg. C. before it begins to become plastic. Schott has stated that thermometer glass should be made with sodium salts, and should contain no potassium, as the samples containing the latter metal show a greater alteration of zero.

The author makes the following recommendations: The glass for thermometers should be well selected; the empty bulb and tube should be carefully annealed by cooling very slowly; after being filled and sealed, the thermometer should be kept at a temperature as high as may be convenient for a time depending on this temperature. For ordinary thermometers (to be used up to 100 deg. C. only) the ordinary method of seasoning (keeping them for six months at normal temperatures) may suffice, although the operation would be shorter at a higher temperature. High-temperature thermometers should be kept in an air-bath (or otherwise) at 450 deg. C. for three or four days, after which they may be calibrated with the expectation that they will be subject to but slight alteration of the zero subsequently.

MAPPING A MONKEY'S BRAIN.

EMINENT surgeons have long endeavored to find out exactly what parts of the brain control the various muscles and limbs of the body. With that information accessible, new ways would undoubtedly be devised for treating diseases of the nervous system.

Sufferers from nervous complaints, especially such as cause interruption of muscular action, may have reason to bless the memory of certain great apes who have co-operated unselfishly with, and without being consulted by, some British scientists and surgeons in a series of privately conducted experiments to demonstrate new facts about the brain. Although the scientific partnership proved fatal to the apes, they died scientifically respected. Several photographs will be handed down to a grateful medical posterity. Studies of the brains of the higher apes have shown that their composition was sufficiently like that of a man to justify the belief that investigations would furnish knowledge of the human brain. In order to understand the experiments it must be remembered that the brain may be roughly divided into two great portions—the frontal and the occipital—which are separated by the fissure of Rolando. This fissure extends across the top of the human head and down at each side at about the region of the temples.

All that part of the brain which lies in front of it—that is, the brain that is over the eyes and fills out the frontal region of the head—is known as the frontal lobe.

This frontal lobe, it has been found, does almost all the work of ordering and controlling the motions of the body, and the exercise of its various physical functions.

It is the great central telephone exchange, or, to use another electric term, the great power house where the subtle, intangible fluid of thought is converted into a tangible working force and thence transmitted at varying pressures along the feed wires of nerves to the various engines of the heart, arms, eyes, mouth, nose, and other organs.

The apes that were used for the experiments were chimpanzees. The chimpanzee is placed as being next to the gorilla in brain development. The gorilla comes immediately after man, and the chimpanzee follows. The orang-outang is third.

The animals were anaesthetized, and tiny openings made in their skulls. Great care was taken to prevent shock and to cause no suffering of any kind either during the operation or subsequently.

This was dictated not only by humanity, but also by scientific requirements, for the action of the brain could not have been studied with any promise of precise results had the conditions not been as nearly normal as possible.

After the wound had healed entirely one electrode from an electric battery was fastened to the wrist of the chimpanzee in the form of a bracelet and the other electrode, in the form of a fine platinum point on a spring, was brought to touch the outer surface of the brain softly and gently, avoiding any undue pressure.

Thus, as the experiments progressed, with many monkeys the areas that controlled the movement of the organs and limbs of the body became mapped out bit by bit.

If a certain part of the cortex of the frontal lobe of the brain received the current, the ape thrust out his fingers; the current applied to another place made him thrust out his tongue.

Other impulses made the eyes close suddenly or the arms and legs move and jerk. All these things happened apparently much to the victim's astonishment and often dismay, for they certainly had no intention of performing such acts.

It was highly comical to see the amazed and alarmed expression on the face of a chimpanzee when his left hand suddenly clenched itself without his desire, and then as suddenly shot forward. He looked as if he thought that he had been bewitched.

After the experiments had been concluded it was found possible to make a map of the brain that left hardly an inch in doubt as to its function, so far as the frontal lobe was concerned.

A curious fact is that the extremities furthest away from the brain are controlled by parts of the brain well on the top of the head. The eyes and other organs of the face are controlled from the lowest part of the frontal bone.

The top of the head, just behind the forehead, con-

trols the toes. Immediately below it lies the center that sends orders to the ankle. In front of these two are the centers that command the knee and the hip.

The shoulder is controlled from a center that lies almost underneath that line on the forehead where the hair begins. A little lower down is the elbow center.

Below that again is the dynamo that sends currents through the wrist.

Over the eyes and between the temples in the forehead are the telegraph stations that connect directly with the fingers and thumb.

The power impulses that control the eyes and eyelids are in that part of the brain which lies almost directly behind them.

Under and behind the eye-controlling portion is the portion that has charge of the jaw. There are two distinct jaw centers. One controls the opening and the other the closing of the jaw.

Further inside of the brain are the cells that control the vocal chords and the organs of mastication. Two cases of injury to human brains which have since been treated according to the knowledge obtained from these experiments proved that the discoveries of the motor centers furnished fair working bases for treatment of the human patient.

SOME GERMAN DRILLING MACHINES.

In the accompanying drawing (Fig. 1) we show the Phœnix drilling machine constructed by Messrs. Habersang & Zinzen, of Düsseldorf-Oberbilk, for the purpose of simultaneously drilling a number of holes in flanges, girders, boilers, etc., and specially intended for large works, the advantage offered by the use of the machine being that when a number of pieces are to be drilled in the same manner it is not necessary to mark more than one piece, for after the drill spindles have once been set according to the marks on the first piece any number of pieces can be drilled to exactly correspond with this one.

In the machine shown in Fig. 1 the counterbalanced spindle carrier is provided with six drills. Power is transmitted from the upper driving shaft by means of cone pulleys and gear wheels to a short vertical shaft which is journaled in the upper part of the spindle carrier, and by means of other gear wheels this shaft drives all the spindles simultaneously. Each spindle consists of three parts, of which the upper part, with its drive wheel, is fixed in the spindle carrier, while the lower part forms one piece with the drill holder; both of these parts terminate in clutches that are engaged by the ends of the middle portion of the spindle (Fig. 2). As allowance must be made for variations in the length of the latter, it is formed of a round stem and a tube fitting over the same, the stem being pressed outward by a spiral spring. In order that friction may be avoided steel balls are introduced in the spindle joints. The spindle holders above referred to are set in a ring—the so-

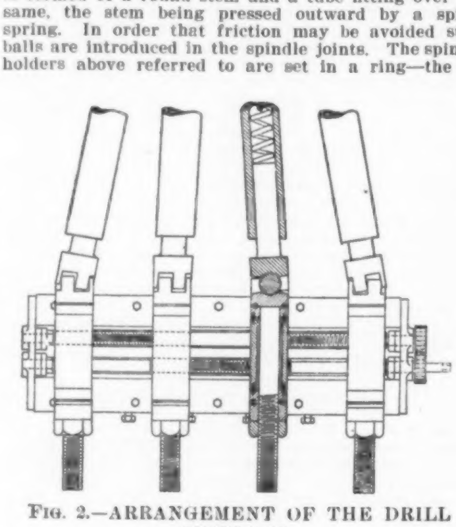


Fig. 2.—ARRANGEMENT OF THE DRILL SPINDLES.

called spindle head—on the lower end of the spindle carrier, in which they are fastened by means of bolts. The spindle carrier moves up and down automatically, but this operation can also be accomplished by hand. Several self-centering devices are provided for use in mounting the pieces of work.

This firm has also built another machine, called the Phœnix boiler-drilling machine, in which the drills are arranged on a line, so that four holes can be drilled simultaneously in the longitudinal seams, for instance, of a boiler.

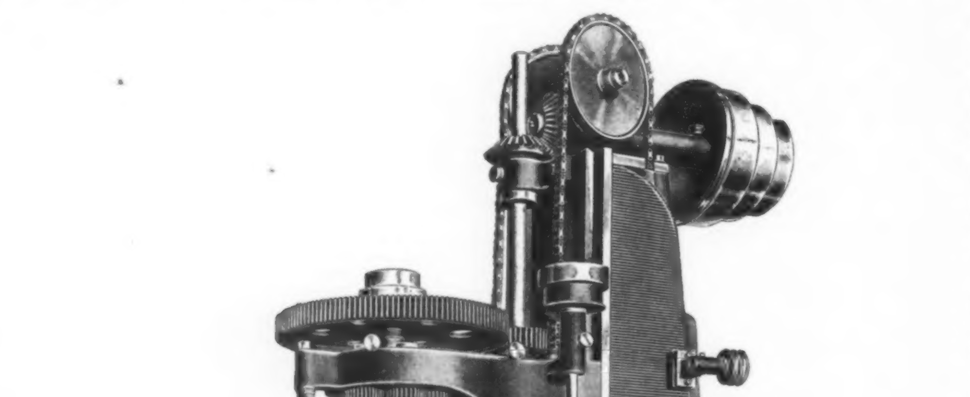


Fig. 1.—PHŒNIX DRILLING MACHINE MADE BY HABERSANG & ZINZEN.

In Figs. 3 and 4 we illustrate a portable drilling machine made by Collet & Engelhard that is specially intended for drilling out the staybolts of fireboxes and cutting threads in the holes thus formed, but it is also very useful for boring or reaming out holes when setting up apparatus. This machine can easily be moved from place to place, wherever it may be needed, and in order that it may stand quite firmly a plate is provided near each wheel, which plate can be screwed down. The resistance necessary during the operation of drilling is obtained by the adjustment of the support connected, as shown in Figs. 3 and 4, with the top and bottom of the upright column of the machine. This support is raised and placed on the machine when the latter is to be moved about. The foot of the upright column is arranged to slide on the ground plate for a distance of 1½ yards by means of a hand lever and a rack and pinion; while a vertical sliding movement, for a distance of about 2 yards, can be given to the casing which is mounted on the upright column and carries a one horse power electric motor and the drills. To facilitate this latter movement, also accomplished by hand, the casing is provided with a counterweight placed in the hollow column. The drill spindle can be set at any desired angle in the vertical plane, as the drill casing can be turned around the horizontal axis of the electric motor. The drill spindle is driven by a device (not shown) consisting of a worm wheel and sets of gear wheels arranged to give four different velocities. The tool is worked forward slowly by means of a hand wheel which is also provided with a worm gear, while the quick backward movement of the spindle is obtained by means of another hand wheel. The motor is provided with reversing apparatus, so that the spindle can revolve in both directions.

The method of using this apparatus is also shown in Figs. 3 and 4; in the former it is applied on the outside and in the latter on the inside of a firebox.—For the accompanying drawings and the above data we are indebted to Glaser's Annalen für Gewerbe und Bauwesen.

IGNITION DEVICES FOR GAS AND PETROL MOTORS.

By S. R. Bottone.

Ever since the advent of the gas engine, and of its congener the "oil engine," much ingenuity has been displayed in the construction of suitable contrivances for igniting the explosive mixture. It will be evident, on the slightest consideration, that the conditions to be fulfilled will necessarily vary with the varying circumstances in which the engine is to be employed, and that an igniter which would be eminently suitable for a stationary gas engine might be quite inapplicable to a portable petrol motor forming part of an automobile car, or of a motor-driven bicycle. As much interest has been evinced by our readers in this subject we make no apology for presenting the following epitome of the more important devices in use for this purpose, with a few remarks as to their fitness or unsuitability for certain particular requirements.

In the very earliest commercially successful gas engine, that of M. Lenoir (1860) the means adopted for firing the explosive mixture was an electric spark. As in this engine no attempt was made to secure compression of the gaseous mixture, no particular care was taken to *time the spark*. "As the piston advances it draws in an explosive mixture of gas and air. About mid-stroke this is ignited by an electric spark." In the Otto and Langen engine (1867), in which also there was no compression, the ignition was effected by a small gas flame, to which the gaseous mixture gained access at the desired moment through the action of a special slide valve, which opened and closed a porthole facing the gas flame. In the Otto engine of 1876 *compression* was adopted, and the compressed mixture was fired just when the forward stroke was about to begin, by means of a slide valve alternately uncovering and covering a hole facing a small gas flame. In the "Priestman" petroleum engine, electric ignition, in the shape of sparks generated by an induction coil, was the means first adopted; the slide valve being the same as in the Otto. In more recent forms of oil engines the ignition is effected by a flame produced by a blow-through oil lamp, of the "Ætna" or "Primus" type. This lamp itself requires frequent attention to keep up the supply of vaporized oil, on which its own flame depends. For all stationary work no form of ignition is perhaps so satisfactory as that adopted by Crossley Brothers, in which a tube, either of porcelain or of a suitable metal, is kept nearly white hot by a Bunsen flame playing in its interior. Neither tube nor direct-flame ignition lends itself readily to small petrol motors, such as are usually adopted in cars, tricycles and bicycles. For these electric ignition presents many advantages.

The means employed for igniting by electricity are various: First, maintaining a thin platinum wire (placed close to the slide valve) in a state of incandescence by the current from a battery. Secondly, producing, by the aid of a coil and battery, a continuous stream of sparks before the slide-valve. Thirdly, the production with the coil and battery of sparks between the platinum points of an igniter, which is inserted in the explosion chamber of the engine, the time at which these sparks take place being controlled by a cam, or other device that makes (or breaks) the circuit at the required instant. Fourthly, the production of sparks directly from a magneto-machine, or from a dynamo driven by the motor itself. Fifthly, producing sparks from a composite machine called a "dynamo coil," in which the field-magnet and *its* winding form at the same time the core and primary of the sparking coil, which therefore admits of accurate timing of the spark by interrupting the circuit in the primary. Of these, the first may be dismissed from further consideration, since it is very difficult to maintain a platinum wire at the point of incandescence by the battery current, without either fixing it, if the current exceeds the normal, or allowing it to become too cool if the current falls below that point. Besides this defect, the platinum wire is very apt to become encrusted with unburnt carbon derived from the gas. The fourth method is open to the

objection that efficient sparks are produced by the magneto (or dynamo) only when the speed at which it is driven reaches a certain point; and, moreover, that when that speed is increased, there is considerable risk of breaking down the insulation of the generator. These objections have not much weight when the engine is stationary, running at a practically constant speed; but they become serious in cases of tramcars, motor-cars, or any other vehicles in which the speed is liable to sudden variations. We are therefore driven to the conclusion that coil ignition in some form or other is the best for general purposes. (It may be pointed out here that even in the case of stationary engines electric ignition is superior to any form of flame or tube, as it economizes gas or vapor.)

Whatever form of coil be adopted (with the sole exception of the dynamo coil) a battery must be employed in conjunction with it, to supply the current necessary to cause it to produce sparks. Now, it is just at the battery that all the troubles begin. In stationary engines it is a nuisance to have to replace dry cells, or to dismount and remount primary cells of any kind. The former quickly fail to give sufficient current, and must be replaced; the latter more gradually, but just as surely, lose power, and must be renovated. The only battery that can be depended on to give a sufficiently equable current for any length of time is an accumulator of fairly large ampère-hour capacity. This is really the best, we might say the only satisfactory, source of current which can be used for working the coil. But the accumulator must be recharged. This is not a serious matter in the case of stationary engines, where access can be had to a charging station, or where a portion of the power of the engine can be deviated from the general work, to drive a dynamo from which a spare accumulator can be charged. But when we come to deal with accumulators to be fitted into petrol-engined launches, petrol motor-cars, motor tricycles or bicycles, in which the success of a trip depends on the condition of the accumulators, and in which it is frequently impossible to have recourse to a charging station, some means of maintaining the accumulator charged to a working point becomes a matter of the highest importance. We can now pass to the consideration of the requirements in a dynamo suitable for stationary gas or petroleum engines. Circumstances only can decide whether it will be more convenient to allow a portion of the spare power of the engine to be employed continuously for the purpose of keeping the accumulators charged, or whether a certain time in each day shall be set aside to attain this end. In the former case, the dynamo must be fitted with some automatic device (called a "cut-in and cut-out"), which shall break the circuit between the dynamo and the accumulator whenever the dynamo gives less than the required charging voltage, and shall complete the circuit when the voltage reaches the necessary point. The automatic cut-in and cut-out is an absolute necessity in all cases in which the engine is subjected to variations in speed, due to different loads being put on her. In the case of a certain time each day being set aside solely for charging, the employment of the cut-out, though convenient, is not so imperative, since the dynamo attendant, by keeping his eye on the voltmeter, can immediately switch out the dynamo, if he finds the voltage falls below the necessary 2.5 volts per cell. It is needless to remark here that whatever type of dynamo be employed, it must be *shunt* wound, or if compound, the shunt coils alone must be employed. *Series* wound machines and *alternators* are of no use for this purpose. The particular type of machine is of no great moment; ring and drum armatures are the best, but the outward form, all other things being equal, is of some importance. In large establishments in which the dynamo can be kept away from the general workshops any good dynamo, whether open or inclosed, is admissible, and in fact the open type presents some advantage in presenting easy access to the brushes, etc., for regulation. But in all cases in which dirt or dust is present in the dynamo-room, the machine should be of the inclosed type. We do not mean by this that the dynamo should simply be inclosed by a covering, whether of wood or of metal; but that its construction should be such that the entirety of its working parts (with the exception of shaft and driving pulley) should be inclosed in *iron*, this iron forming an active portion of its field-magnet system. The first real iron-clad dynamo was devised by Mr. Tighe in 1882. In this a single wound pole arose from the center of an iron cylinder, the top of the cylinder being dome-shaped and forming the other pole of the dynamo, the armature playing between the central pole-piece and the dome. A very similar pattern, excepting that the cylinder terminated in a circular cap, was designed by Mordey for the Brush Company. This form has been largely adopted by more recent makers as being at once efficient, compact, and having its working parts fully protected by the massive outer iron cylinder.—English Mechanic.

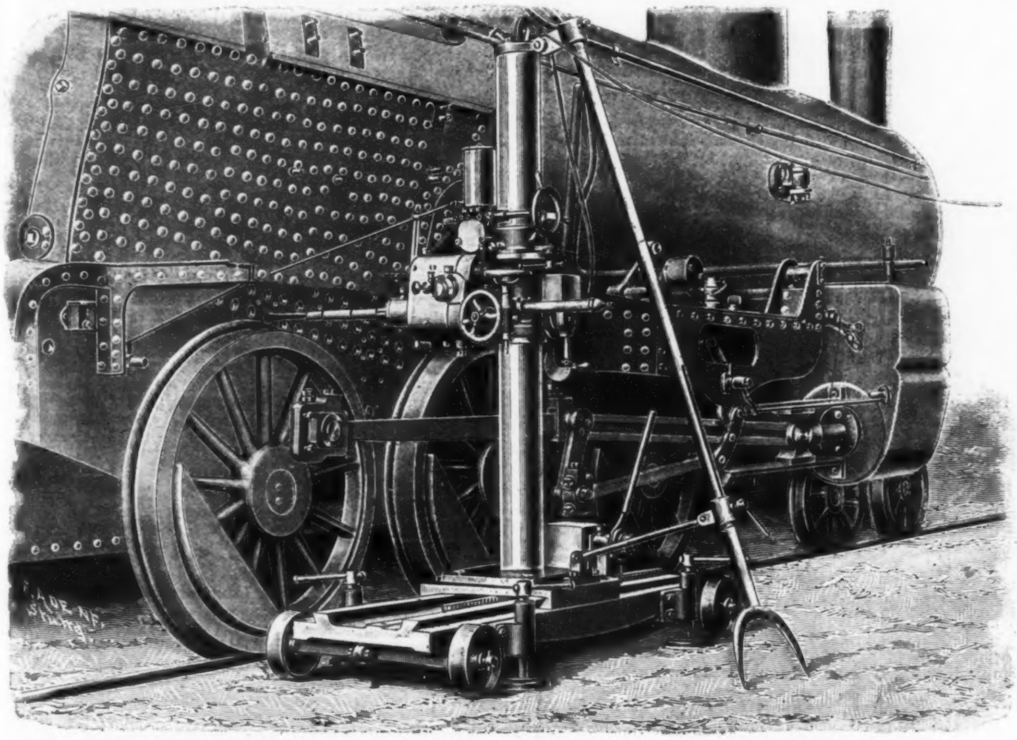


FIG. 3.—BORING OUT STAYBOLTS FROM THE OUTSIDE WITH MACHINE MADE BY COLLET & ENGELHARD.

ROPE DRIVING.

THEORY has frequently to be modified in practice. This is principally due to the fact that in the making of theoretical deductions points which vitiate or modify these deductions are easily overlooked. We learn slowly, and most of us a little at a time. We concentrate our minds on certain points, and never think of other points until actual contact with practical arrangements leads us into further inquiries.

Take as an illustration rope driving. Careful experiments, as in those at Lille in 1896, have been made to obtain trustworthy data as to the respective efficiencies of belt and rope driving. In one table of these experiments we find that 158.54 horse power was exerted with ropes and 158.84 horse power with a leather belt. The slip of the ropes was 0.33 per cent, and that of the belt 0.96 per cent.

Let us take one aspect of belt and rope driving in actual practice. With a belt drive we have a particular ratio between the pulleys dependent on the diameters of the pulleys and the creep, or slip as it is termed in the Lille experiments, of the belt. That creep or slip alters with the condition of the belt, and may alter with the weight driven by it if that weight causes increased stretch on the belt when the weight is increased. In the majority of cases the difference of the ratios caused by creep is immaterial. In other cases, as in that of paper making machines, any variation is accounted for by attaching pieces of felt to the driver or driven pulleys as the tension on the paper may require.

For a rope drive we will take a main drive consisting of a 14-foot diameter pulley with twenty ropes driving on to a 7-foot diameter pulley. We take for granted that the grooves are turned to the same gage and are precisely the same depth. The ropes are well stretched and spliced. They run well. By and by some of the ropes wear out, and require renewing. Five new ones are put on, and these run at the original ratios of 14 to 7. The other fifteen ropes are much thinner than the new ones, and sink ½ inch deeper into the grooves. The ratio with them is therefore 13 feet 11 inches to 6 feet 11 inches, instead of 6 feet 11½ inches. The old ropes gain on the new ones to the approximate extent of 1½ inch every revolution of the 7-foot pulley, or the new ropes gain the mastery and the old ropes slip.

What takes place is usually that the new ones brake the old ropes until the new ones are rubbed down to the same diameter. At first the new ropes are tight. If the tight side is underneath then the new ropes, being actually driven by the old, sag underneath. The sag on the top side is determined by the stress on that side caused by the 7-foot pulley overrunning the new ropes. The blame is usually attributed to the stretching of the ropes. Should the race not be deep enough the new ropes may strike the bottom, cutting themselves useless. They are tightened again, and not having now sufficient sag to strike the bottom they are rubbed down until they acquire uniformity of diameter with the old ropes. During this state of things others of the old ropes may give way under the extra stresses. When the ropes have settled down finally—the new ones partially destroyed—they may run a long time without giving trouble. This sort of thing often leads to unfair comparisons, of course unintentionally, between different kinds of ropes, as Manila and cotton. The drastic remedy is, or would be, to throw off all the old ropes—an expensive matter—or tie back all the old ones as a reserve to replace the bad ones of the second set when they have worn to the same diameters as the tied-back ropes. This is open to objection, and as a rule is impracticable owing to want of room. The circumstances give a point in favor of the American system of rope driving—that of one continuous rope. But it will be seen that these difficulties put a different complexion on rope driving from what would be gathered from experimental trials.—Engineering.

PREPARATION OF AGGLOMERATES OF CALCIUM CARBIDE FOR THE MANUFACTURE OF ACETYLENE GAS.

By MESSRS. DESQ AND FRANCONAL.

ONE thousand grammes of commercial molasses are heated in a vessel having an agitator, in a vacuum at 110 deg. C. to free it from its water. Then the temperature is lowered to 95 deg. to 100 deg., the mixture being kept in constant agitation during this decrease of temperature. One hundred grammes of finely powdered potassium bichromate is then mixed with the dehydrated molasses. This slowly thickens, and its color changes, until it finally assumes a very pronounced bottle-green hue. Two hundred grammes of sodium carbonate (Solvay salt) and 200 grammes of

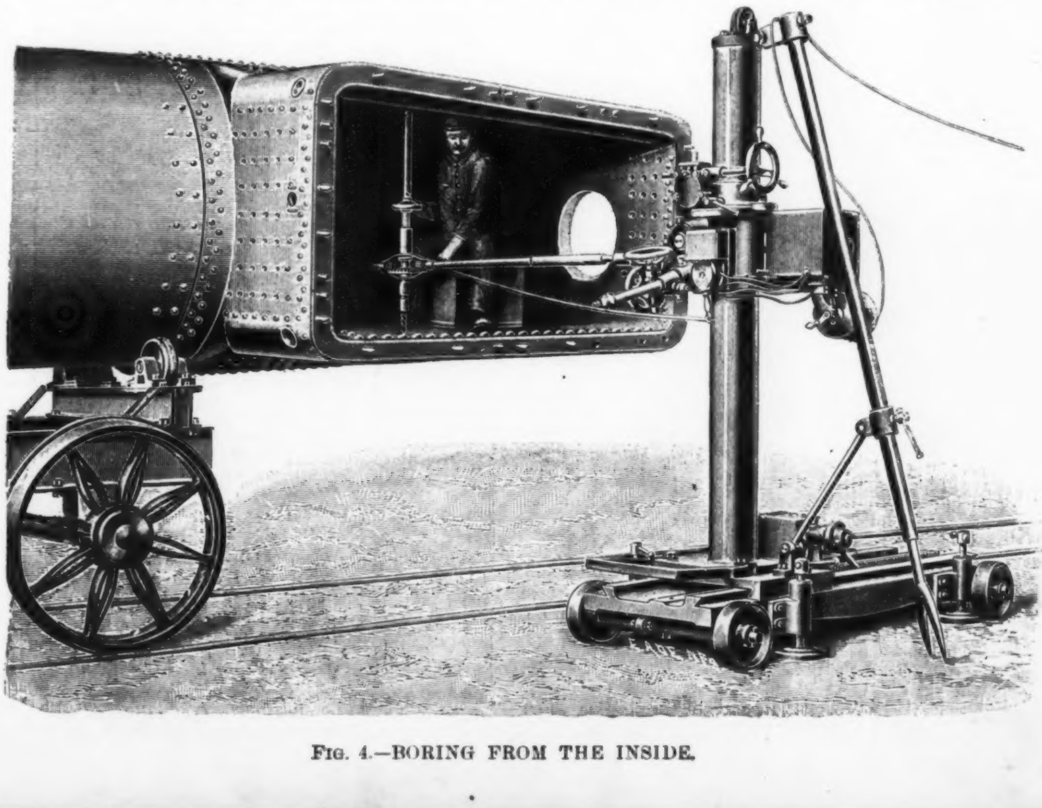


FIG. 4.—BORING FROM THE INSIDE.

litharge, finely powdered and previously mixed, are now introduced into the molasses without permitting its temperature to fall below 85 deg. to 90 deg.

It is shaken rapidly until a liquid paste as homogeneous as possible is obtained. To this paste are added 2,500 grammes of calcium carbide in fragments of 4 to 5 milligrammes, previously soaked in a mixture of:

Rectified petroleum	600 grammes.
Oil of turpentine	400 grammes.
Camphor	10 grammes.

The whole is constantly shaken, and the temperature maintained between 65 deg. to 75 deg. C., until the carbide and paste are well mixed.

The mixture, thus prepared, is introduced into molds heated to 50 deg. C., and pressed to exclude the excess of the compound. After thoroughly cooling, the agglomerate is removed from the mold, in the shape of a candle or some other object, and wrapped in parchment or paraffine. As a further precaution, to prevent the action of moisture on the exterior of the agglomerates, they may be soaked, after removal from the mold, in a cold solution of albumen.—La Revue des Produits Chimiques.

EMIGRATION FROM BRITISH INDIA.

THE India Office has communicated a statement, together with tables, showing the emigration from British India in recent years, which is published in the Board of Trade Journal.

From these statistics it appears that the number of emigrants from India during the five years 1885-86 to 1900-01, and the number of returned emigrants during the same period, was as follows:

	Number Emigrated.	Number Returned.
Five years ending 1885-86	73,312	32,546
" " 1890-91	62,332	39,194
" " 1895-96	72,977	30,304
" " 1900-01	95,616	31,186
Total	304,237	133,230

The mortality among emigrants is high in some of the colonies to which they go, and of those who survive, a substantial proportion elect to continue to work in the colony after their term of indenture expires, and many of these never return to India. In Mauritius, for instance, about 69 per cent of the population (261,739 out of a population of 379,659) are Indian settlers and their descendants; in Demerara a third of the population of the colony consists of Indians; and in Natal, Trinidad, and elsewhere, the settled Indians are increasing in numbers.

There are five places in India from which emigration may be legally carried on—Calcutta, Bombay, Madras, and the two French settlements of Pondicherry and Karikal. From Bombay emigration ceased many years ago, and general recruiting has never been resumed, labor in the Western Presidency being, on the whole, so well paid that there is but little inducement to emigrate to the coolie-employing colonies. That port and the port of Karáchi, however, have recently been used for the shipment of male laborers destined for work on the Uganda railway, who were recruited under agreements made with or on behalf of His Majesty's government. Over 27,000 such laborers, mostly recruited in the Punjab, have left Karáchi for that purpose in the last three years. From the French settlements there has been no emigration since 1884, except in one year, 1888-89. The port of Calcutta is the most convenient for the shipment of emigrants drawn from the impoverished masses of the thickly populated districts of Oudh, Bihár, and the eastern section of the Northwestern Provinces, and the main stream of emigration flows from that region down the Hooghly. Of the persons who emigrated from India in 1900-01, 11,510 (being 43 per cent) were shipped from Calcutta, the greater number of them from the Northwestern Provinces, Oudh, Native States, and Bihár. Their destinations were British Guiana, Trinidad, Natal, Mauritius, and Fiji. From Madras 6,966 were shipped during the year, recruited exclusively from the Madras Presidency, mostly from the southern (Tamil) districts. These went to Natal and Mauritius. There is a considerable flow of native laborers from Madras to Ceylon and the Straits, but this traffic is not conducted under the provisions of the Emigration Act.

The destinations of the emigrants in the last five years were as follows:

To	1896-97.	1897-98.	1898-99.	1899-00.	1900-01.
Mauritius	802	426	—	—	3,229
Natal	4,038	6,080	4,958	1,590	6,312
Demerara	2,417	1,194	2,380	4,959	8,092
Trinidad	3,043	1,851	1,268	1,798	2,450
Dutch Guiana	500	618	616	—	—
Fiji	1,953	567	—	1,490	2,553
Jamaica	—	—	623	670	—
Mombasa	2,819	2,798	9,479	9,931	8,032
Other destinations	—	—	249	—	—
Total	15,572	13,485	19,613	20,438	26,508

The figures in the tables appended to the above statement relate solely to emigration as carried on under laws regulating emigration. They take no account of the numbers who leave India as passengers, not having been recruited by emigration agencies for service in the Colonies, these being separately dealt with. The tables also take no account of persons who leave India on pilgrimage to the holy places in Arabia, of whom small but uncertain numbers settle out of India.—Journal of the Society of Arts.

ELECTRICITY DIRECT FROM COAL.

THE latest of the many indefatigable attempts made to obtain electricity direct from coal is that of Hugo Johe, of Chicago. He has obtained the patent on a new battery. In his invention a retort is employed, which is surrounded by a cylindrical case containing a battery of four cells. The furnace gases from the retort circulate against the inner side of the cell and case.

Partitions of porous coal divided each cell into three sections, containing respectively nitric acid, sulphuric acid and ferric chloride solution. In the nitric acid an electrode is immersed, and in the narrow chloride solution a lead electrode.

The operations are as follows: A suitable quantity of sulphate of lead is placed in the retort with a quantity of coal nearly sufficient to reduce the sulphate to sulphide, and the mixture is then heated until all of the coal is oxidized. The sulphide is freed from impurities which may have been brought into it by the coal, and is then mixed with sulphate of lead in sufficient quantity to yield metallic lead and sulphur dioxide, which reduction is effected by again applying fuel heat to the retort. The sulphur dioxide passes through a pipe into the larger section of the several cells, reducing the ferric chloride therein to ferrous chloride. Previous to this the generation of the electric current is started by putting the lead electrodes into the larger section and suitably connecting them with the carbon electrodes. The current may be considered as consisting of two currents, one generated by the action of the ferric chloride of the lead electrode, and the other by the action of the nitric acid through the interposed porous walls, and sulphuric acid by means of molecular exchange of ferrous chloride. The flow of sulphur dioxide is so regulated that the sulphuric acid formed is not more than sufficient to decompose the chloride of lead formed in the battery reaction. The lead in the retort is allowed to flow into a pan, where it is suitably shaped or solidified for an electrode. The sulphate of lead deposited by the battery is allowed to accumulate, and at intervals is drawn off by means of siphons, and the deposit of sulphate of lead electrode removed. The temperature of the battery is regulated so that the nitric acid which enters into the sulphuric section is evaporated, the vapors being passed through a condenser and there condensed again to nitric acid, flowing back into the nitric acid sections through a pipe. This process of distillation, oxidation, and condensation is kept up by regulating the temperature of the battery and supplying sufficient cooling water to the condenser. Thus oxygen is supplied to the nitric acid, while the generation of electric energy with consumption of oxygen goes on. The E. M. F. of the cell at 100 deg. Cen. is said to be about 1.75 volts.

TRADE NOTES AND RECIPES.

Carbonated Beverage.—In putting up "lemon soda" and similar bottled drinks one must, of course, have a bottling machine to begin with. The base of such beverages is carbonated water, and this is prepared in exactly the same way as for dispensing at the soda fountain, and the bottles must be filled under pressure. In selecting flavors for the water one must consider the question of solubility. While it is not necessary in dispensing at the fountain to have sirups clear, they must be approximately so, at least if one would have bottled soda water present a satisfactory appearance to the usual customer.

It is well known that oil of lemon is very sparingly soluble in water so a strong sirup cannot be made from it which will give a "bright" water. So, for beverages of the kind under consideration it is desirable to use the terpeneless oil. Oil of lemon owes its characteristic flavor to citral and several other bodies, all of which are present in but small proportions. The terpene constituting the bulk of the oil is comparatively insoluble, and by its removal we get the flavoring material in a much more concentrated form, and from this a clear aqueous solution can be made of ample strength. Instead of terpeneless oil, citral may be used with the ordinary oil of lemon, about one of the former to fifteen of the latter. By thus strengthening the latter, a lesser quantity will, of course, give an essence of customary strength, and the operator is thus helped in the matter of solubility. The essence will in the latter case, however, probably not be quite the equal in flavor to one made from the whole oil, as a characteristic ingredient or ingredients are present in this which are required to give the proper quality, and the proportion of these is changed, of course, by the addition of the citral.

The remarks concerning lemon oil apply with more or less modification to other flavoring oils. In some the proportion of terpene is small as in oil of sassafras, so that not much would be gained by its separation.

The amount of sirup and flavoring to be added to a given quantity of carbonated water varies according to taste and price. No hard and fast rule can be given.—Druggists' Circular and Chemical Gazette.

Artificial "Ice Flowers."—As everyone has observed, ice crystals as they form on windows and elsewhere are often very beautiful. Some years ago Molish published a process by which he claimed to be able to produce imitations of these crystals. The National Druggist suggested then in reporting it that if the process proved successful in the hands of pharmacists they would have at command a new and attractive decoration for the show window. This suggestion is still in order, and the directions for forming the so-called ice flowers are as follows:

Make a 2 per cent solution of the best and clearest gelatin in distilled water, filter, and flood the filtrate over any surface which it is desired to ornament, a plate of glass, for instance. Let drain off slightly, and if the weather is sufficiently cold, put the plate, as nearly level or horizontal as possible, out into the cold air to freeze. In freezing, water is abstracted from the colloidal portion, which latter then assumes an efflorescent form, little flowers, with exuberant, graceful curves of crystals, showing up as foliage, from all over the surface. To set these in permanent form all that is necessary is to flood them with absolute alcohol. This treatment removes the ice, thus leaving a lasting framework of gelatin which may be preserved indefinitely. In order to do this, however, as soon as the gelatin has become quite dry it should be either varnished, flowed with an alcoholic solution of clear shellac, or the gelatine may be rendered insoluble by contact, for a few moments, with a solution of potassium bichromate, and subsequent exposure to sun light.—Druggists' Circular and Chemical Gazette.

To Remove Old Varnish Coats.—These coatings are removed by the application of a mixture of about 5 parts of potassium silicate (water glass, 36 per cent), about 1 part of soda lye (40 per cent) and 1 part of spirit of sal ammoniac. The composition dissolves the old varnish coat, as well as the paint, down to the bottom. The varnish coatings which are to be removed may be brushed off or left for days in a hardened state. Upon being thoroughly moistened with water the old varnish may be readily washed off, the lacquer as well as the oil paint coming off completely. The spirit of sal ammoniac otherwise employed dissolves the varnish, but not the paint.—Deutsche Maler Zeitung.

SELECTED FORMULÆ.

Odorless Disinfectants.—The following formulas are taken from former issues of the Report, and are said to yield very efficient preparations:

1.	Ferric chloride	4 parts
	Zinc chloride	5 parts
	Aluminium chloride	5 parts
	Calcium chloride	4 parts
	Manganese chloride	3 parts
	Water	69 parts

If desired, 10 grains of thymol and 2 fluid drachms of oil of rosemary, previously dissolved in about 12 fluid drachms of alcohol, may be added to each gallon.

2.	Alum	10 parts
	Sodium carbonate	10 parts
	Ammonium chloride	2 parts
	Sodium chloride	2 parts
	Zinc chloride	1 part
	Hydrochloric acid	sufficient
	Water	100 parts

Dissolve the alum in about 50 parts of boiling water, and add the sodium carbonate. The resulting precipitate of aluminium hydrate dissolve with the aid of just sufficient hydrochloric acid, and add the other ingredients previously dissolved in the remainder of the water.

3.	Mercuric chloride	1 part
	Cupric sulphate	10 parts
	Zinc sulphate	50 parts
	Sodium chloride	65 parts
	Water	to make 1,000 parts

—Druggists' Circular.

White Ink.—So-called white inks are, properly speaking, white paints, as a white solution cannot be made. A paint suitable for use as an "ink" may be made by grinding zinc oxide very fine on a slab with a little tragacanth mucilage, and then thinning to the required consistency to flow from the pen. The mixture requires shaking or stirring from time to time to keep the pigment from separating. The "ink" may be preserved by adding a little oil of cloves or other antiseptic to prevent decomposition of the mucilage.

White marks may sometimes be made on colored papers by the application of acids or alkalies. The result, of course, depends on the nature of the coloring matter in each instance, and any "ink" of this kind would be efficacious or otherwise according to the coloring present in the paper.—Druggists' Circular and Chemical Gazette.

Fertilizer for Potted Plants.—The following odorless solution for fertilizing potted plants was devised by Prof. Paul Wagner, of Darmstadt:

Ammonium phosphate	30 grammes
Sodium nitrate	25 grammes
Potassium nitrate	25 grammes
Ammonium sulphate	20 grammes
Water	100 liters

Paste for Mounting Photographs.—

I.

Gelatin	4 ounces
Water	16 ounces
Glycerin	1 ounce
Alcohol	5 ounces

Dissolve the gelatin in the water, then add the glycerin, and lastly the alcohol.

II.

Arrowroot	1 ounce
Water	10 ounces
Gelatin	48 grains
Alcohol	1 ounce

Soak the gelatin in the water, add the arrowroot, which has first been thoroughly mixed with a small quantity of the water, and boil four or five minutes. After cooling, add the alcohol, previously dissolving in it a few grains of salicylic acid.

III.

Best Bermuda arrowroot	1¾ ounces
Sheet gelatin or best Russian glue	80 grains
Water	15 ounces
Alcohol	1 ounce
Water	15 ounces

Put the arrowroot into a small pan, add 1 ounce of the water and mix thoroughly with a spoon or the ordinary mounting brush, until it is like thick cream; then add the remainder of the water and the gelatin broken into small fragments. Boil for four or five minutes, set it aside until partially cold, then add the alcohol, previously dissolving in it a few grains of salicylic acid. Be very particular to add the spirit in a gentle stream, stirring rapidly all the time. Keep in a corked stock bottle and take out as much as may be required for the time.

IV.

Starch in powder	3½ ounces
Gelatin	2 drachms
Alcohol	2 ounces
Solution of formaldehye (40 per cent)	1 drachm
Water	30 ounces

Soak and dissolve the gelatin in the water, heat to boiling, and pour, with constant stirring, on to the starch, previously mixed to a cream with a little cold water. When nearly cold add to the paste the formaldehyde solution.

We think it likely that these pastes will be less adhesive than one made from flour, but, on the other hand, they probably have the advantage of being whiter if very white gelatin be employed.—Druggists' Circular and Chemical Gazette.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Market for American Billiard Tables in Austria.—An Austrian, who has just returned to Trieste after several years' residence in the United States, in a recent conversation with the writer, remarked that if the superior merits of the American billiard table became generally known in this country, Austrian billiard players would refuse to play on any other. This gentleman also informed me that he had decided to import on his own account fifteen American tables and cause them to be set up in this city.

The above-mentioned conversation has led me to investigate the relative merits of American tables and those in general use in Austria. I find that the better kinds of billiard tables are almost exclusively imported from France. There was a time when France led the world in this line, but the comparative monopoly which the French manufacturer has enjoyed for so many years has caused him to become ultraconservative, and the French product, having undergone scarcely any change during the past twenty-five years, is now far behind its American rival, which the genius of the inventor and the enterprise of the manufacturer have year after year brought to a higher state of perfection.

Briefly stated, the superiority of our billiard tables consists in their greater solidity, trueness, and the ease with which they may be transported.

On the French table, the cushion frame is not fastened to the slate. It therefore yields more or less when struck by a ball, which rebounds with an audible thud. On the other hand, the cushion frames of the American tables are firmly held to the sides of the slates by long screws. This causes the ball to rebound noiselessly—an advantage greatly appreciated, as my informant assures me, by nervous players.

The superior cloth and cushions of American tables accounts for their greater precision or trueness. The best billiard cloth is made in Belgium, but it is said that it is manufactured exclusively for an American firm, which thus controls its sale, with the result that on European tables, standard cloth is rarely met with. It is claimed that good billiard cloth should be both thin and firm enough to prevent the cue, should it strike it, from leaving in it depressions likely to deflect the ball from its true course. In this respect, the cloth usually found on French tables leaves much to be desired.

The cushions, also, are imperfect and unreliable. They soon become uneven and lose their elasticity, causing balls to rebound at wrong angles and frustrating the calculations of the player.

Last, but not least, while the slate of the American table consists of three different pieces, that of the French is one solid piece, and this adds greatly to the risk and expense of transportation. In this connection, it may be stated that the American manufacturer, in obtaining his slate from native quarries, has a decided advantage over his French rival, who is compelled to import his supply from India.

The cost of a standard French table (about 3 feet 8 inches by 7 feet 4 inches), laid down at Trieste, is from 1,200 to 1,250 crowns ($243 to $253). It appears to me that at such prices, Austria would be an inviting market for our manufacturers. It might require a little effort to introduce our billiard tables into this country, but, once established, they would be here to stay.

The duty on French tables amounts to from $12 to $25 apiece, according to weight, finish, etc. As all Austrian duties are specific, the importation of heavy frames is not advisable. Moreover, the various parts of a table, such as the frame, cloth, rubber, etc., should be packed and entered separately, as quite a saving of duty is thus effected. Wooden furniture, and parts of wooden furniture, plain or polished, pay only 5 florins gold per quintal; but if the wood is covered with cloth, or is combined or connected with any other material, it pays 30 florins gold ($12.80), and even more, per quintal (220.4 pounds). The duty on billiard cloth is comparatively low, being 50 florins gold ($20.30) per quintal if the cloth weighs over 500 grammes (16 2-3 ounces) per square meter (1.14 square yards), 80 florins gold ($32.48) if it weighs 500 grammes (16 2-3 ounces) or less per square meter, and 110 florins ($44.66) if it weighs 200 grammes (6 2-3 ounces) or less per square meter.

It is difficult to say how patent cushion rubber would be classed by the Austrian appraiser. The duty on such articles varies from 10 to 30 florins gold ($4.06 to $12.80) per quintal, according to their quality and composition. A trial shipment is usually necessary to have them definitely classified.

Frames intended for importation into Austria should be entirely plain, as carved, pressed, or inlaid work is subject to an almost prohibitive duty. Even the few small geometrical figures of ivory, pearl, or fine wood, usually inserted in the upper surface of the frame to aid players in their calculations, should be omitted. If they are really indispensable and American genius cannot contrive a substitute for them, they should be inserted after importation.—Frederick W. Hossfeld, Consul at Trieste.

Brazilian Tariff Law for 1902.—Consul Furniss sends from Bahia, January 10, 1902, the following translation of such sections of the tariff law, passed by the Brazilian Congress December 23, 1901, and effective January 1, 1902, as he thinks of interest to American trade:

By Article 2 the Executive is authorized to effect the following:

Section 2. To adopt a differential tariff up to 50 per cent in favor of one or more imported articles in compensation for concessions to Brazilian products under the favored-nation treatment, or vice versa.

Sec. 5. To recover from vessels using the ports a duty of 1 to 5 reis (0.0005 to 0.0025 cent at present rate of exchange) per kilogramme (2.2 pounds) of merchandise loaded or discharged, to be expended in improvements of the respective ports.

(*a*) The proceeds of this duty, which shall be proportionate to the requirements of the service, shall constitute a special fund for each port, destined exclusively for the respective improvements.

(*b*) Goods transshipped from one vessel to another, owing to the first being of greater draft than is admitted within the zone comprised in the improvement, shall be exempt from this duty.

(*c*) To accelerate the execution of the works the government is authorized to accept donations or chargeable pecuniary assistance from the States, municipalities, or associations which may be benefited by the improvements, provided these charges do not exceed the proceeds of the above-mentioned duty.

Sec. 8. To exempt from duties all materials imported by the States or municipalities for the supply of water, the metallic material for drainage, road locomotives and rolling stock for traction on roads without rails, instruments and apparatus for professional and technical instruction imported by the State institutions and by the schools maintained by the federal government.

(*a*) All vessels and crafts exclusively employed in fishing and all apparatus, instruments and articles imported for the service of the same and those for the preservation of fish shall be free from all taxes.

Article 4.—From the date of the present law samples of all beverages and foodstuffs imported must be submitted to the laboratory of analysis in the order of their arrival.

Section 1. The table of analysis shall be exclusively for the importer's use.

Sec. 2. In the event of wine being shipped in barrels of different sizes, the sample submitted to the laboratory shall be in proportion.

Sec. 3. After the payment of the proper tax by the importer the national laboratory will commence the analysis within the following time:

Six working days, maximum, for the analysis of the quality of wine, beer, cider, vinegar, bitters, vermouth, effervescent lemonade, mineral water, olive oil, liquors, and simple sirups.

Fifteen working days, maximum, for the analysis of flours, alimentary pastes, tea, chocolate, curd, preserved meat, fish, milk, vegetables and fruit, oil for lubrication and for other industrial purposes, soaps, tissues, natural and artificial essences, and alloys of metals.

Thirty working days, maximum, for the analysis of butter, lard, tallow, and all greasy products of a composite nature, cognac, rum, whisky, alcohol, and other strongly alcoholic substances and unenumerated products.

Sec. 4. The laboratory shall be obliged to furnish a certificate of the receipt of payment, fix the day and hour for the presentation of the receipt, and return the fee paid, in case the analysis has not been commenced within the stipulated time.

Sec. 5. If after the expiration of the specified time the laboratory should not have commenced or finished the analysis, the party shall be permitted to dispatch the goods, presenting the certificate mentioned in Section 4 to the custom house, which shall advise the Minister of Finance of the fact the same day.

Sec. 6. The time for the quantitative analysis shall be fixed by the director of the laboratory, with a view to the maximum urgency.

Sec. 7. Quantitative analysis of products suspected to contain noxious substances shall not be comprised in the terms mentioned, as it may be necessary to repeat the analysis on a fresh sample.

Article 6.—All agricultural implements and machinery imported direct by the planter shall be free from duty, as also all apparatus for the milk industry.

(*a*) The detailed dispatch of these articles shall be submitted direct to the Minister of Finance.

Article 8.—The 25 per cent of the duties payable in gold on imported merchandise, of which 5 per cent will continue to be reserved for the fund in guarantee of the currency, shall be collected as heretofore.

Canadian Tariff Changes.—Consul-General Turner sends from Ottawa, February 18, 1902, a newspaper clipping re articles placed on the free list by an order in council passed February 17, as follows:

By order in council the following articles have been placed on the free list:

Hemp-bleaching compound for the manufacture of rope.

Silver tubing for the manufacture of silverware.

Steel for the manufacture of cutlery.

Yarn of jute, flax or hemp, for the manufacture of towels.

Steel castings, in the rough, for the manufacture of scissors and hand shears.

All articles entering into the construction and forming part of cream separators. Separators have all along been admitted free.

The duty will be remitted on all materials used in the manufacture of machinery for beet-sugar factories. The machinery itself is already free of duty.

Under date of February 13, Mr. Turner sent a newspaper article referring to the reduction in the duty on paper, as follows:

The government is satisfied that a combination exists among the manufacturers of printing paper in Canada, and in order to bring about competition, has decided to reduce the duty on news print from 25 per cent to 15 per cent.

In April last the Canadian Press Association represented to the government that the price of printing paper was very much higher in Canada than in the United States, and offered, if given an opportunity, to prove that this advance was due to a combination or agreement among the paper manufacturers of Canada to keep up prices. This appeal of the newspaper publishers was based upon what is known as the anti-combine clause of the tariff act of 1897. This clause provides that whenever the governor in council finds that the manufacturers of any article have formed a trust or an agreement to unduly enhance prices the government may obtain evidence and place such article on the free list, or so reduce the duty on it as to give to the public the benefit of reasonable competition.

Judge Taschereau, of Montreal, was appointed to make the inquiry, and after full investigation he reported to the government last November sustaining the complaint of the Press Association. As a result an order in council was passed yesterday to this effect:

"The customs duty on news printing paper, in sheets and rolls, including all printing paper valued at not more than 2¼ cents per pound, shall be reduced from 25 per cent to 15 per cent ad valorem."

Judge Taschereau, in his report to the government, says that an agreement within the meaning of the tariff act above quoted does exist. On February 21, 1900, the twenty-six manufacturers of paper in Canada formed an association. The agreement between the manufacturers embraces all sales in Canada and Newfoundland, but does not embrace paper exported out of the Dominion, with the exception of Newfoundland. The principal provision of the agreement binds the contracted parties not to sell goods at lower prices or on better conditions than those agreed upon.

Judge Taschereau concludes that this agreement constitutes an association which amounts to a combination. As to whether the combine resulted in unduly increasing prices, he finds the proof that it did so in the fact that in 1896 the price of rolled news print was $2.75 per 100 pounds; that the price fell steadily till November, 1899, when it was $2.03 to $2.10; when the association was formed, the price rose to $2.50. There was also a rise in the United States, but when prices fell there they were kept up in Canada. He declares that the present paper makers' combination is illegal, both by the express enactment of the customs tariff and by section 520 of the criminal code.

During the fiscal year 1901 there were imported into Canada 7,534,558 pounds of paper, more than double the quantity imported in 1900. The value was $356,086, and the duty paid thereon $80,566.

Trade Conditions in Chile.—Commerce between the United States and Chile has materially increased during the quarter ended December 31. Large shipments of American lumber have been received at the port of Valparaiso, large contracts for coal have been secured by American firms, trade in American paper has greatly increased, and orders for various other goods have been placed with United States houses. The present outlook for trade between the two republics is more favorable than at any time in recent years.

A number of representatives of American firms have recently arrived in Valparaiso to solicit business for their respective companies, and in nearly every instance they have secured liberal orders.

Every mail from the United States brings to this consulate a large number of letters and catalogues from manufacturers and exporters. The catalogues are placed in the hands of local merchants and importers and the business letters answered, giving the names of dealers who handle the line of goods represented. This plan keeps local merchants informed of the class, variety and quality of goods offered by manufacturers and exporters in the United States. Many Valparaiso merchants also apply to the consulate for information concerning American goods.

In this connection I wish to say that many American firms that go to the trouble and expense of writing to United States consuls and to merchants in foreign countries do not attach sufficient importance to their letters. In some instances these communications are mimeograph copies, or are circular letters printed upon a poor quality of paper; in others, the signature of the writer is attached with a rubber stamp. As a rule little attention is paid to such letters, the majority of which are promptly thrown into the waste-paper basket. Business letters addressed to merchants in foreign countries should be neatly and carefully prepared, and a good quality of stationery should be used. The signature should be written with a pen. It gives the prospective buyer a better impression of the house sending out the letters, and these will not only be read, but generally filed away for reference.—R. E. Mansfield, Consul at Valparaiso.

Possibilities for American Coal in Smyrna.—There are practically no coal mines in Turkey, and 99 per cent of all the coal used here is imported from England. Reports from the larger markets of Europe show that American coal is gaining ground in competition with the English product; there is no reason why this should not be the case in Turkey. Important arrivals of American coal are noted in France, Italy and Russia, whereas none has appeared in Turkey. Possibly the principal obstacle in the way of introducing American coal into this country has been the affiliation of native coal merchants with English exporters. This can be readily overcome by applying to merchants who have not hitherto been identified with the coal trade and who can be easily induced to arrange for sample shipments.

The use of coal in Turkey is steadily increasing, through the construction of railways from Smyrna, Constantinople, Mersine, etc., into the interior of Asiatic Turkey, and from Constantinople, Salonica and Dedagatch into European Turkey. New shipping lines are giving more attention to Turkish ports and are generally in need of coal upon arrival at Smyrna and other ports of the Levant. Coal is also used for industrial purposes in limited amounts. The coal contracts of the Ottoman Gas Company expire next June, and that company would be glad to experiment with a sample of American coal. In general, Cardiff and Newcastle coal is preferred in Smyrna, but pure Cardiff is rarely found. The kinds more often bought are Nautyglo and Griffen, from Newport mines. The best quality of Nautyglo corresponds to Cardiff coal; Griffen coal, a lower grade, is especially used by locomotives. According to specifications of the railway companies the coal must be of fresh extraction and contain only traces of sulphur. Fifty per cent of each cargo must consist of large lumps, and the amount of dust must not exceed 15 per cent.

The annual consumption of coal in Smyrna and vicinity is about 150,000 tons, of which 80,000 tons are taken by steamers, 30,000 tons by railways, and 40,000 tons by the Ottoman Gas Company and other industries. The actual price c. i. f. Smyrna for Nautyglo coal, which is largely mixed with Griffen and sold under the name of Cardiff, is 22s. to 23s. ($5.34 to $5.58) per ton. The present favorable freight rates make it possible for American coal producers to lay their coal c. i. f. Smyrna at from 2s. to 3s. (48 to 73 cents) under the cost of English coal, and this is sufficient reduction to induce local consumers to give it a trial. Cargoes can be unloaded directly on wharf or by lighter. Return cargoes can frequently be picked up. If samples or analyses, with quotations, are addressed to me, they will be delivered to local consumers.—Rufus W. Lane, Consul at Smyrna.

Foreign Market for American Phosphates.—I would call the attention of those interested to an article of export from the United States in which the trade has of late developed to such dimensions as to lead to the opinion that the business is destined to a large expansion. Reference is made to what is termed the rock phosphate of Florida, as well as to a certain quality called the Tennessee variety, coming, I understand, from the State of the same name. An individual engaged in the importation of the substance states that about 25,000 tons arrived here during the last two months, and that contracts are out at present for something like 20,000 tons of the Florida variety and for about 17,000 tons of the Tennessee, to arrive shortly.

This business, my informant states, is done through a Liverpool house and the transportation costs from 14s. 6d. to 16s. ($3.42 to $4.19) per ton from Pensacola. The freight is considered an excellent one for steamers from our southern ports, inasmuch as it furnishes excellent ballast, and vessels can ordinarily obtain additional cargoes of cotton and light bulky substances to make the voyage profitable.

It will be understood that the substance referred to is imported in the crude state and pulverized here.

My informant further states that there is nothing on the market to compare with the product above named, in cases where a high fertilizing power is demanded, and taking prevailing prices into consideration.

For ordinary purposes this country as well as France produces a sufficient supply, but the variety produced in our country seems destined to replace the guano of Peru and the nitrates of Chile. He also states that France alone last year imported something over 200,000 tons and this year will probably take 100,000 tons more, while the demand from Baltic ports is also on the increase.

This subject is a matter which should prove of interest to capitalists contemplating the resuscitation of our merchant marine.—Geo. F. Lincoln, Consul-General at Antwerp.

Industrial Exposition at Osaka, Japan.—In reply to an official inquiry, the Japanese Department of Agriculture and Commerce has furnished this office with information showing that the coming National Industrial Exposition, under the auspices of the Imperial government, will be held at Osaka from March 1 to July 31, 1903, and that it will present a novel feature, to which the general attention of foreign manufacturers and the industrial world is called.

This feature is the establishment of a special building for samples of articles produced or manufactured in foreign countries. It is not concealed that the primary object of this invitation is to afford Japanese manufacturers an opportunity to study the latest products of Western invention, with a view to the improvement of Japanese industries; but it is claimed that in return the establishment of the building in question offers to foreign manufacturers a rare opportunity for exploiting the rapidly developing markets of the whole Far East, as the exposition is expected to attract immense crowds of visitors from the continental countries of Asia, in addition to the millions of Japanese.

Gold Mine in the Netherlands.—Consul Listoe sends from Rotterdam, January 11, 1902, translation of an article which has lately appeared in several of the Dutch newspapers, as follows:

"The provincial government of Overysel has received a request for a concession to develop a mining field in the community of Hellendoorn, Overysel, which has an area of 2,046 hectares (5,056 acres). The petitioners offer, in case of deep mining, to pay the owners of the soil a remuneration of 12.50 florins ($5) per hectare, and in case of surface mining, 400 florins ($160) per hectare."

New Ore Separator in Sweden.—Consul Bergh reports from Gothenburg, November 13, 1901:

The Morning Post, of this city, says that Knut Ericson, an engineer, has invented an apparatus for the separation of ore by the magnetic method, and last September exhibited it before Swedish and foreign experts. The apparatus, which is very simple in construction, yet ingenious, attracted wide attention. A Swedish company is being organized to work the invention. It is believed that it will be of the greatest importance for mining.

Demand for Wire Tacks in Melbourne.—Deputy Consul-General Hanauer transmits from Frankfort copy of a letter from a British agent of an Australian and New Zealand firm (address of agent, Hopetown House, Lloyds Avenue, Fenchurch Street, London, E. C., England) reading:

My Melbourne friends, Messrs. McLean Brothers & Rigg, Limited, ask me to write you to request wire-tack manufacturers to submit samples and prices of goods. If you will kindly let me have some names I shall be glad to mail them to my friends in the colony.

FRANCIS CHAPMAN.

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